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FLATHEAD BASIN FOREST PRACTICES  
WATER QUALITY AND FISHERIES  
COOPERATIVE PROGRAM

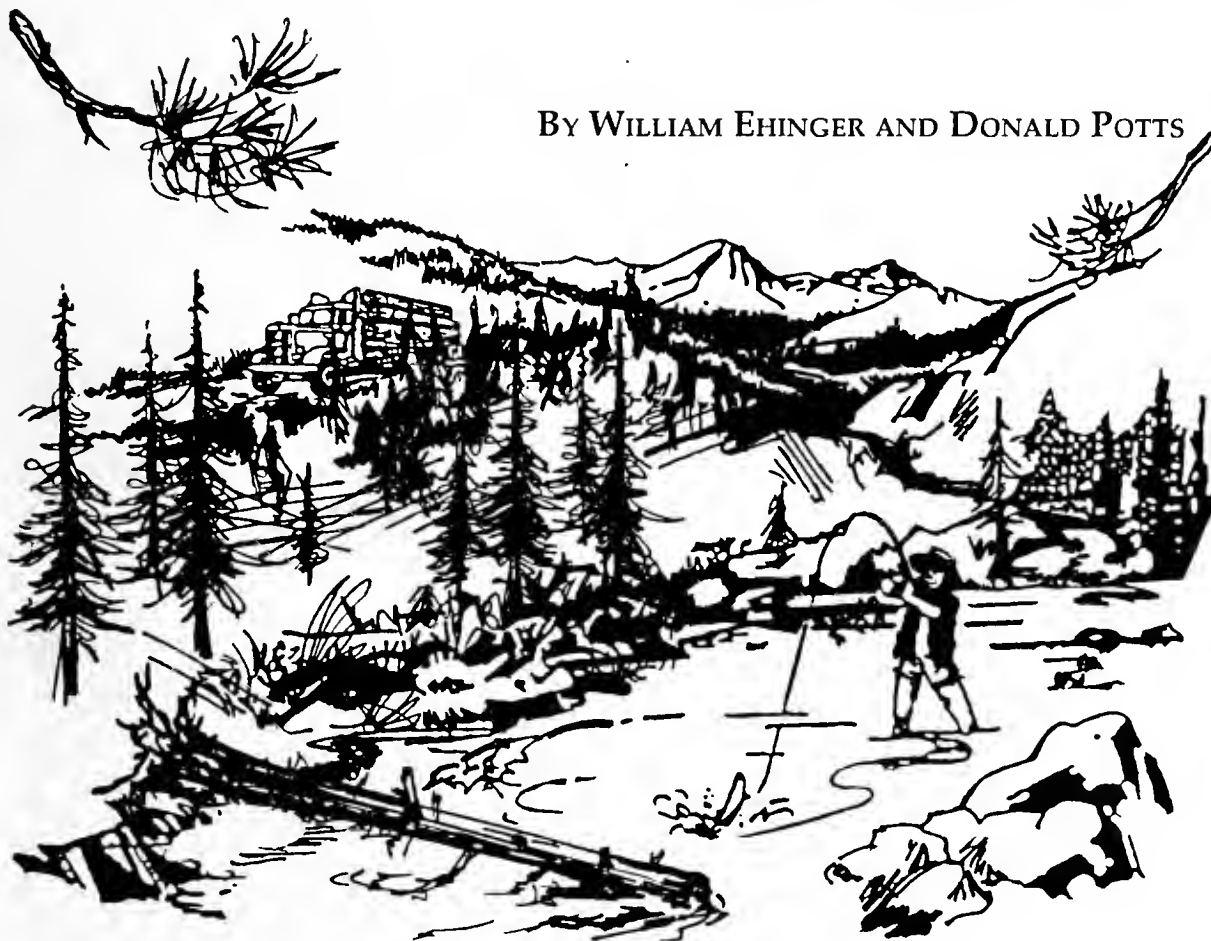
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ON-SITE ASSESSMENT OF  
BEST MANAGEMENT PRACTICES AS AN INDICATOR OF  
CUMULATIVE WATERSHED EFFECTS  
IN THE FLATHEAD BASIN

BY WILLIAM EHINGER AND DONALD POTTS



JUNE 1991

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## ABOUT THIS REPORT

This report is one of ten individual studies conducted for the Flathead Basin Forest Practices/ Water Quality and Fisheries Cooperative Program. The Cooperative Program was administered by a Coordinating Team representing the Montana Department of State Lands Forestry Division, the Flathead National Forest, Plum Creek Timber Company, L.P., the Montana Department of Fish, Wildlife and Parks, the Montana Department of Health and Environmental Sciences' Water Quality Bureau, the University of Montana, and the Flathead Basin Commission.

The Cooperative Program's specific objectives were (1) to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Basin, and (2) if detrimental impacts exist, to establish a process to utilize this information to develop criteria and administrative procedures for protecting water quality and fisheries.

The ten individual studies included the evaluation of: (1) specific practices at the site level, (2) accumulation of practices at the watershed level, (3) general stream conditions, (4) water quality variables relative to levels of management activity in small watersheds, (5) fish habitat and abundance relative to stream variables influenced by forest practices at the watershed level, (6) long-term changes in large-stream dynamics related to historical records of natural and man-related disturbances, and (7) changes in lake sediments relative to historical records of natural and man-related disturbances. A *Final Report* was developed which contains summaries of each of the studies, a set of summary conclusions and recommendations, and a formal response to the recommendations by the land management organizations which administered the Cooperative Program.

## CONTRIBUTORS

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Montana Department of Fish, Wildlife and Parks  
Flathead Basin Commission  
Montana Environmental Quality Council  
Montana Chapter of the American Fisheries Society  
Governor's Office, State of Montana

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FLATHEAD BASIN FOREST PRACTICES  
WATER QUALITY AND FISHERIES  
COOPERATIVE PROGRAM

ON-SITE ASSESSMENT OF  
BEST MANAGEMENT PRACTICES  
AS AN INDICATOR OF  
CUMULATIVE WATERSHED EFFECTS  
IN THE FLATHEAD BASIN

BY WILLIAM EHINGER AND DONALD POTTS

JUNE 1991

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FLATHEAD BASIN COMMISSION  
723 FIFTH AVENUE EAST  
KALISPELL, MONTANA 59901

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FLATHEAD BASIN WATER QUALITY

AND

FISHERIES COOPERATIVE

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ON-SITE ASSESSMENT OF BEST MANAGEMENT PRACTICES AS AN

INDICATOR OF CUMULATIVE WATERSHED EFFECTS

IN THE FLATHEAD BASIN

\*FINAL REPORT\*

Prepared by

William Ehinger

and

Dr. Donald Potts

University of Montana School of Forestry

June 1991

## ACKNOWLEDGEMENTS

I consider myself extremely fortunate to have had the opportunity to work closely with many fine people who dedicate their time and energy toward the management of Montana's natural resources. Credit for the success of this study is largely due to the support and assistance provided by a long list of individuals.

Office personnel at the Department of State Lands-Forestry Division, Plum Creek's offices, and each Flathead National Forest District office put up with my presence in their work areas, rooting around through computer databases and file cabinets, or repeated phone calls for assistance. Timber sale administrators juggled their field schedules, during the busiest season, to lend their knowledge and cooperation.

A special thank you to the team members who agreed to participate in this study. These individuals took a considerable amount of time away from their regular jobs to tackle this special project - on top of their otherwise packed summer field schedules - and then remained committed to see the project through it's completion. The experiences and expertise they shared, their patience and flexibility in working with the process, the air conditioned vehicles which they volunteered and their comments and advice were all truly appreciated.

When the weather turned soggy in camp, Jeff Collins and Dean Sirucek provided welcome shelter from the storms. Thanks to Ken Lull for filling in for me in the field for a day. A special acknowledgement to Kim Sherwood for his hardiness in taking his bedroll out under the evening showers, when he had a perfectly dry tent, his polite and courteous attention to the travelers in the Flathead Valley, and most of all his companionship and conversation during a wonderful summer spent in the "Flathead." To you all, may we some day tip another cool one on a warm evening, along the shores of Flathead Lake, or maybe "El Oso...".

To my wife and daughter, their absentee husband and father is home again, loves them dearly and appreciated their understanding and support of my effort on this project.

Finally, a simple thank you doesn't seem sufficient to express my gratitude to Dr. Donald Potts and Hugh Zackheim, without whose efforts this project, and my participation, would not have been a reality.

Bill Ehinger

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## EXECUTIVE SUMMARY

In 1988, the Flathead Basin Forest Practices/Water Quality and Fisheries Cooperative was formed to address questions and concerns surrounding forest management and water quality in the Flathead Basin. The Cooperative has funded a series of research projects in the Flathead Basin to assess cause-and-effect relationships among forest practices, water quality and fisheries. In particular, the projects are concerned with identifying cumulative watershed effects.

One of these projects used a forest practice monitoring tool which involves on-site assessments of Best Management Practices (BMPs). The BMP assessment was intended to measure the level of practice application and practice effectiveness in preventing soil erosion and protecting water quality in the Flathead Basin.

The BMP assessment had two objectives: 1) The results would document the level of application and skill in implementation of the State's voluntary Best Management Practices, and their effectiveness in controlling nonpoint source pollution, and 2) A comparison would be made between these results and those of the 1988 Montana Legislature's Environmental Quality Council (EQC) statewide BMP assessment.

This report includes a thorough examination of the methodology of BMP assessment. The various aspects of

setting up the study and conducting the field work are discussed. This information is summarized to document procedures and shed light on possible alternatives and suggestions for improving similar studies in the future.

In order to provide a basis for comparison with the work of the EQC, similar site selection criteria were utilized in this study. A stratified random sample of 52 timber sales were selected from 4 land ownership groups: Flathead National Forest - 22 sales; Plum Creek Timber Company - 19 sales; Montana Department of State Lands - 6 sales; and Non-Industrial Private - 5 sales. All timber sales were harvested between January 1986 and December 1988. Each sale was evaluated on up to 39 separate practices. These practices corresponded to the Best Management Practices for Forestry (December 1988 revision) developed by the Environmental Quality Council's BMP Technical Committee. Ratings were carried out by 3 teams, each composed of 5 members representing industry, state and federal agencies, and environmental groups. Each team member had technical expertise in some aspect of forest or watershed management.

The Flathead Basin timber sale audits revealed that 90 percent of all management practices were adequately applied; 7 percent of the practices were rated "minor" departures; and 3 percent were rated as "major" departures. Generally there was a close correlation between the failure to

adequately apply a BMP and the resulting impact which was observed. Major BMP departures produced major resource impacts.

In 8 of the 52 sales (15 percent), audit teams identified at least one practice as having "major detrimental impacts on soil and water resources." Impacts were considered "extensive and long term" in 2 of these sales. The "major" impacts observed on the other 6 sales were considered to impart short term effects.

In 31 of the 52 sales (59 percent), audit teams identified at least 1 practice as having "minor detrimental impacts on soil and water resources". Minor impacts were all considered to be of short duration.

The impacts have been summarized by the major categories of BMPs identified on the audit form. The "Timber Harvest" category, which represents 11 of the 39 practices audited, contributed the greatest number of potential impacts to water quality - more than 30 percent of all impacts, both "major" and "minor", came from this one category alone. Most of these deficiencies were associated with practices in the streamside management zones (SMZs) and with the location and drainage of skid trails.

The "Road Drainage" category involved 5 of the 39 practices audited, but accounted for over 20 percent of all "major" and "minor" impacts observed.

The Montana Department of State Lands' timber sales were the only ones on which major impacts were not observed. Major impacts were most frequently found on the Private Non-Industrial sales, and 40 percent of their sales had at least one major impact. The Flathead National Forest and Plum Creek Timber Co. rated very similarly with approximately 14 percent and 16 percent of their sales, respectively, registering at least 1 major impact.

This assessment included the same set of BMPs that were audited in the 1988 EQC field study, as well as additional or amended practices added to the audit form as a result of adopted changes in the BMPs resulting from the HJR 49 report. Most of those changes involved improvements of practices associated with streamside management zones, including a minimum SMZ width criteria. This practice was evaluated to determine its present level of application in the Flathead Basin, but was not included in the comparative analysis with the EQC results.

Overall, the ratings indicate that BMPs are being applied and are effective in a relatively high percentage of timber harvesting operations in the Flathead Basin. Care must be exercised in interpreting results based solely upon the percentage of the practices rated as "adequately applied." Extensive erosion was observed on a number of sales and it resulted from only a few inadequately applied practices. Every practice evaluated did not have the same

potential to protect water quality from nonpoint source pollution.

Comparison of these results with those from the EQC study indicate that BMPs are better applied and are generally more effective in the Flathead Basin than they are statewide.

However, there is clearly room for improvement. It was found that 1 "major" (either short- or long-term) impact to water quality is occurring for every 2 timber sales conducted in the Flathead. It was also found that almost 2 "minor" (short- term) impacts per timber sale were occurring.

The damage to a watershed resulting from a single timber sale with major practice departures and impacts is generally easy to recognize. However, minor impacts should not be underestimated and are a concern from a cumulative effects perspective. The primary benefit from an assessment process like a BMP audit is to reduce the potential risk of cumulative watershed effects. Discovering and controlling minor practice departures and impacts from various timber sales across mixed ownerships, may decrease the potential for basin-wide effects.

The highest scores (best BMP implementation) awarded were frequently on sites where harvest boundaries were adjacent to perennial streams that had clearly defined banks

and channels and easily recognized beneficial uses (eg. trout habitat).

Often the lowest scores given were on sites that would not have been expected to produce potential water quality problems. This illustrates the need for a program of continued education to aid in interpretation and selection of correct practices under a variety of site conditions.

Timber sales on which departures and impacts were more frequently observed were characterized by the following:

- \* Non-Industrial Private ownership. This ownership class registered the poorest performance in BMP application and effectiveness. Furthermore, the group was the least cooperative participant in the study, frequently denying us access to their lands.
- \* Large management areas, where uniform practices were applied and not tailored to micro-site conditions
- \* Higher-elevation headwaters drainages with poorly defined stream channels
- \* Wet or moist sites with either shallow water tables and/or high stream drainage densities.
- \* Older sales where planning of transportation systems and sale layout pre-dated the recognition of statewide BMPs.
- \* Sales which did not physically mark or delineate

streamside management zones.

- \* Inadequate road drainage features on active system roads as well inadequate drainage on roads that have been closed.
- \* Sales which lacked a routine maintenance schedule for ditches, culverts, and road surfaces.
- \* Sales which were conducted on highly erodible soils, where the increased risk of sediment production requires an adjustment in the frequency and standards of erosion preventative measures.

Other findings and recommendations:

- \* No formalized process to conduct BMP assessments exists, although assessments are periodically conducted on the Department of State Lands by their hydrologist and soil scientist.
- \* Refinements in the BMP audit process are needed to remove the subjective nature of the process and tailor the rating scales to more specifically address nonpoint source pollution and sediment delivery.
- \* Efforts at educating loggers, equipment operators and sale administrators have been initiated by the Montana Logging Association and Plum Creek Timber Company's Kalispell management unit. A comprehensive cooperative program of education, either through instructional tapes or training

sessions is needed. The goal of the education effort would be to reach a targeted number of operators, administrators and sale planners throughout the Basin.

- \* Improve the communication and flexibility between the sale planning and sale administration on U.S.F.S.. This would allow for the administrator to adjust sale boundaries and harvesting systems for improved BMP compliance.
- \* Improve communication between the sale administrators and equipment operators to identify areas of sales, including the SMZs, which require special treatment or specialized best management practices.
- \* Implement clear delineation of SMZs to aid equipment operators in recognizing them.
- \* Increase on-site interaction between sale administrators and soil and water specialists. This would allow for more complete review of site conditions and adjustment of practices for better resource protection.
- \* Adopt targets for achieving BMP application and effectiveness goals for all forest management activities in the basin. Develop a consistent procedure for future BMP audits to monitor

progress toward reaching these goals.

- \* BMP assessments, by themselves, are unsuited for quantification of any cumulative watershed impact, but do address this problem through the fundamental assumption that if BMPs are properly applied and effective, then cumulative watershed effects may be minimized.

This study provided the first opportunity for many Flathead Basin resource professionals from both timber industry and land management agencies to participate in BMP assessment. The feedback we received from many participants indicates that much of the value of this effort was in education. The active participation in the field reviews and the interest of many individuals in the Flathead Basin is important to the continued success of such efforts. Only with support and encouragement from the upper levels of management will programs such as this nonpoint source monitoring project work.

## INTRODUCTION

Management of forest lands for timber and non-timber resources has raised a host of complex issues. Protecting non-timber resources during timber harvest requires managers to carefully plan and execute their activities. This requires knowledge of how the land will respond to various activities and a means of monitoring to verify protection and provide feedback to guide us in future management.

Concerns expressed by both resource managers and the public over the impacts of timber harvesting on non-timber resources, such as fisheries and water quality, cause us to look for more accurate and efficient means to achieve resource protection.

In the Flathead River Basin, timber industry and federal and state land management agencies are facing timber supply problems because of appeals and injunctions reflecting public concern for non-timber resources. To address this, the Flathead Basin Water Quality and Fisheries Cooperative was formed to try to answer the basic question "are forest practices affecting fisheries and water quality?" This is a question that can be answered with extensive monitoring.

Unfortunately, monitoring complex relationships in large watersheds is not well-served by traditional quantitative techniques. The optimal method should demonstrate direct cause and effect relationships over a large geographical areas such as the Flathead River Basin, address the complexities of mixed ownership and differing management objectives in watersheds, allow for distinction between man-caused changes and natural variation in water quality, and yield results in a relatively short time. The optimal method does not exist.

One possible starting point, however, is a subjective, qualitative approach utilizing interdisciplinary teams that

rate a series of forest practices and their potential to produce sediment, thereby impacting water quality. Best Management Practices (BMP) assessment is a method that is compatible with the concerns identified above while addressing the issues of non-point pollution and "cumulative watershed effects" for which federal legislation mandates identification and control.

In 1988 the first statewide BMP assessment was conducted by the Montana Environmental Quality Council (EQC). The effort was recognized as an excellent progress report on implementation of voluntary BMPs and their effectiveness in protecting soil and water resources. Recommendations resulting from the EQC study included: 1) continued education to improve the level of compliance and 2) further assessments as a means of monitoring progress.

A primary objective of this study was to intensively replicate that effort in the Flathead River Basin, and compare the results obtained with those from the state-wide study.

Several states throughout the country are presently using this method of monitoring as a tool to measure compliance with their Forest Practices Acts. Montana's non-regulatory atmosphere has relied on a cooperative approach with a voluntary set of practices. Assessments of this kind in Montana are not designed to be punitive in nature. Instead they are intended to serve 4 purposes: to

provide the resource manager with necessary feedback on implementation of the practices across their ownership; to improve the clarity of intent of a practice; to indicate areas in need of increased education; and to measure progress and performance in obtaining goals or objectives associated with natural resource management.

The success of a cooperative monitoring program which employs an interdisciplinary approach, rests heavily upon the spirit and attitude of the participants. The ability of individuals to reach agreement on forest practice application, as professionals and in an objective manner, is crucial to the success of the project.

The atmosphere of these field reviews can be confrontational at times. It is not an easy task to confront individuals with criticism of their work. Nor is it always easy for some individuals to accept that criticism due to anxiety over possible repercussions from it. Reprimands from supervisors, peer-pressure, possible accusations of resource mismanagement, or concerns over the potential misuse of the data by the press or public, all loom as obstacles to achieving our objective. That objective is to carry out a factual assessment of the impacts on water quality resulting from forest practices in the Flathead River Basin. Attention should be focused on the positive aspects and knowledge which these studies

contribute toward improving the future management of natural resources.

This study provides only one piece of the puzzle assessing nonpoint source pollution from forest practices. Further research is presently being conducted which will add to our knowledge of this complex issue.

#### **BMP ASSESSMENTS FOR MONITORING WATER QUALITY**

The Federal Water Pollution Control Act Amendments of 1972 (U.S. Congress, 1972), later renamed the Clean Water Act, mandated in Section 208 that States develop an "area-wide waste treatment management planning process" that must include "a process to (i) identify...silviculturally related nonpoint sources of pollution ... and their cumulative effects ... and (ii) set forth procedures and methods to control ... such sources." While resource managers agree "nonpoint sources" and "cumulative effects" are real and important contributors to water quality problems, they have yet to agree on a method to isolate and quantitatively measure them. Monitoring watersheds to assess the effectiveness of nonpoint source control programs and answering questions regarding the impact of forest practices on water quality poses a unique set of problems. These problems will become more evident upon examining the following definitions.

Nonpoint source pollution resulting from silvicultural practices is a change in water quality that exceeds

"natural" conditions, comes from a multitude of locations, and has no identifiable discharge point for applying control measures.

Cumulative effects are changes in water quality, streamflow, channel structure, or aquatic habitat caused by the interaction of natural ecosystem processes with multiple forest practice operations (EQC, 1988).

One problem with both of these definitions is that they contain a natural component. For states to identify and control nonpoint sources and cumulative effects, a method is needed to identify naturally occurring sediment production and separate it from sediment production resulting from forest practices.

Identifying natural water quality, under pre-disturbance conditions is extremely complex due to the typically large natural variability in water quality. This is due to the interaction of geologic materials and soils, vegetation, climatic events, landforms and land use history. Sampling, in an attempt to capture this variability, requires sophisticated and costly baseline water quality monitoring programs. Large numbers of samples must be collected at the right times to accurately characterize water quality, and sampling should be conducted over a long period to capture the range of climatic events. The cost of a single sediment monitoring station can be up to \$30,000 per year (NCASI, 1988). At these costs few streams can be

adequately monitored, resulting in a lack of available baseline data. Without baseline data, legislation is difficult to enforce, unless operators are caught in the act.

The fact that many watersheds are a mosaic of mixed ownerships further complicates efforts to account for, identify and control nonpoint sources and cumulative effects. A cumulative effect in these watersheds is the result of multiple land owners contributing only incrementally to sediment production. The amounts may be insignificant when considered alone, but in combination with several other sites can be significant. The effects may not be evident for a considerable distance downstream. This makes mixed-ownerships particularly difficult to assess using traditional sampling methods. Problems include a lack of identifiable pollutant discharge points and a lack of baseline data. Perhaps the biggest problem, however, is obtaining a simple inventory of all past activities in large, mixed-ownership watersheds. The inventory would aid in prioritizing monitoring efforts. Consequently, agencies have looked for acceptable substitutes for direct measurements of nonpoint source pollution.

One such acceptable substitute for water quality monitoring is a survey of compliance with Best Management Practices (BMPs). BMPs are developed through methods which draw heavily upon the "best professional judgement" of

resource professionals in the region. They are determined to be the most effective, practical means of preventing or reducing the amount of pollution generated by a nonpoint source to a level compatible with water quality goals.

BMP monitoring can not quantify cumulative watershed effects. But, based on the assumption that if BMPs are adequately applied, and they are effective in controlling erosion, then the likelihood of contributing to a cumulative effect will be minimized.

Federal legislative support for this approach to monitoring can be found in Section 319 of the Clean Water Act of 1987. It requires states to "...identify BMPs which will be undertaken to reduce pollutant loadings resulting from nonpoint source pollution, ... and assess the effectiveness of their silvicultural nonpoint source control programs." Since BMPs are recognized by state and federal legislation as the method to reduce nonpoint source pollution, it is appropriate to incorporate an assessment of BMP compliance into a nonpoint control program. States are increasingly relying on qualitative surveys consisting of on-site assessments of BMPs by interdisciplinary teams to assess their silvicultural nonpoint source control programs (NCASI,1988). States such as California, Idaho, Oregon, Utah and Washington rely on a qualitative approach to assessing nonpoint control.

Recognizing the problems associated with applying water quality standards to nonpoint source activities, the EPA has supported the use of BMP assessment as a substitute for direct monitoring, stating that "...once BMPs have been approved by the state, the BMPs become the primary mechanism for meeting water quality standards" (Jensen, 1987).

In April of 1987, the Montana Cumulative Watershed Effects Cooperative, consisting of federal and state government agencies and private industry, signed a "Memo of Understanding for Adopting and Implementing Best Management Practices for Forestry in Montana." This was the first attempt to identify a set of BMPs statewide. During Montana's 1987 legislative session, the House Joint Resolution 49 directed the Environmental Quality Council (EQC) to study "how current forest management practices are affecting watersheds in Montana, the range of effective management practices to conserve watersheds, the existing administrative framework promoting the use of BMPs, and areas of potential improvement" (EQC, 1988).

A product of the EQC study of 1988 was a revised set of BMPs for the state that incorporated input from a wide range of resource professionals. In addition, they cited the Forestry Division of the Department of State Lands as the lead agency in conducting future audits. Since then the BMPs have gone through yet another revision and were recently approved by the Environmental Protection Agency as

part of the State of Montana's Nonpoint Source Pollution Control Program.

Although BMP assessment has a number of advantages which have made it a popular choice, it is not without limitations. The wording of BMPs is designed to provide some flexibility of interpretation by resource managers, consequently many of the practices lack a clearly defined intent. This produces difficulty in obtaining a consensus on what constitutes an adequate practice. During field assessment, BMPs should be evaluated based on the collective professional judgement of the team members with respect to site-specific needs and the skill of application of the practice. BMPs should not be interpreted to include additional meanings or added levels of protection. Areas where consensus is difficult to obtain should be viewed as possible areas for improvement in the clarity of the BMP language.

It is probably accurate to assume that if difficulty is encountered by resource specialists in the interpretation of BMPs, then opportunities for misinterpretation by operators on the ground will be equally likely.

BMPs alone are not intended to or capable of adequately addressing all water quality concerns associated with forest practices. Assessments to date have only addressed one contributor to the cumulative watershed effects issue - surface erosion. Another component, in-channel sediment

production resulting from the channel scour, is left unaddressed by this process. This latter component can be a significant contributor to increased sedimentation in streams. It results from the increasing water yields and the changing of the timing of hydrologic events associated with removing the vegetative canopy from a site. BMP assessments don't produce finite answers about sediment production resulting from forest management practices. Instead the data are qualitative in nature. The data can be used to make broad statements of practice compliance and effectiveness while pointing to areas in need of improvement.

The BMP assessment process is in its infancy in Montana. This audit of Flathead Basin practices is only the second time an audit of this kind has been conducted in the state. Both audits were patterned after similar efforts conducted by the State of Idaho. Montana should ultimately develop a unique process which may better address the needs of its resource managers and provide a better format for continuing BMP assessment in the future.

#### **METHODOLOGY: THE ASSESSMENT PROCESS**

The two fundamental objectives in the design of this study were to:

1. Minimize opportunity for individual or sampling bias.
2. Utilize as much of the Environmental Quality

Council's BMP study design as possible to provide for the comparison of results.

Areas of concern in study design included:

1. Identification and delineation of drainage basins of greatest concern to water quality problems.
2. Avoiding bias in site selection.
3. Avoiding bias in team selection and team composition.
4. Maintianing consistency in site ratings between teams evaluating different timber sales.
5. Appropriate distribution of sample sites across ownership classes.
6. Distribution of sample sites across erosional hazard classes.

Sampling involved a total of 52 timber sales or cutting units, harvested and completed between 1986-1988. Timber sales or cutting units were first compiled by ownership classes into pools of candidates that met the age requirement for harvest activity, and were within 200 feet of a stream channel.

The number of sales to be visited in each major drainage was proportional to the total timber harvest volume in those drainages between 1986 and 1988, but every major drainage area in the basin had at least 1 timber sale audit.

## STUDY AREA

The Flathead River Basin encompasses nearly six million acres of land and water. A number of contributing watersheds define the boundary of the Basin: 1) Swan River and contributing watersheds; 2) North, Middle and South Forks of the Flathead River; 3) Stillwater River; 4) Tally Lake; and 5) Little Bitterroot River. Table 1 provides a summary of how the timber sales were distributed across the Flathead River Basin.

### Ownership Classes

Timber sales to be audited were stratified into 4 ownership classes. The number of timber sales that were to be audited in each class was roughly proportional to the to the ratio harvest volumes among the ownerships. There were no fewer than 5 sales audited for any ownership class. Distinctions among ownership classes were made to see if ownership was related to BMP compliance. The 4 ownership classes were:

	<u># of sales Audited</u>
1. Flathead National Forest (USFS)	22
2. Department of State Lands	6
3. Plum Creek Timber Co.	19
4. Non-industrial private	<u>5</u>
	52

### Erosional Hazard Classes

The objective of stratifying the timber sale audits by erosion hazard class was to achieve equal representation for

Table 1. Distribution of timber sales in the Flathead Basin.

<u>PRINCIPAL WATERSHEDS</u>	<u># OF SALES AUDITED</u>				<u>TOTALS</u>
	<u>USFS</u>	<u>PLUM CREEK</u>	<u>STATE LANDS</u>	<u>NON-INDUST</u>	
SWAN RIVER	6	8	3	1	18
TALLY LK / LITTLE BITTERROOT	7	10	0	2	19
NORTH FORK FLATHEAD RIVER	4	10	1	0	5
SOUTH FORK FLATHEAD RIVER	2	0	0	0	2
MIDDLE FORK FLATHEAD RIVER	2	0	0	0	2
STILLWATER RIVER	0	0	2	0	2
WHITEFISH RIVER	0	0	0	1	1
FLATHEAD LAKE	1	1	0	1	3
TOTALS	22	19	6	5	52

the wide variety of landtypes identified in the Flathead Landtype Inventory. It was realized that our sample size limits and the existing range of site conditions would not allow a full and adequate sample of all erosion hazard conditions. Nevertheless, this stratification provided for a broad representation of erosion classes while allowing us to meet additional selection criteria.

Stratification of the audit pool at this level was intended to see if the level of BMP compliance was related to the erosion hazards which are experienced on a site. Based on the Flathead Landtype Inventory, sale sites were classified as high, medium or low erosion hazard. Those classes were based on average slope and soil erodibility indicated by geologic parent materials. The placement of

sites in classes was then field tested by having team members try to assess the potential for on-site erosion, and place a timber sale into one of these categories.

#### **SITE SELECTIONS**

Site selection criteria, as follow, were adopted from the 1988 statewide assessment of BMPs done by the EQC, with minor modifications.

1. Timber sales harvested between January 1986 and December 1988
2. Site preparation completed
  - slash piled and burned or awaiting burning
  - slash broadcast burned or scheduled
3. Volume harvested > or = 7 MBF/Acre
4. Cutting unit size of approximately 5 acres or larger
5. Timber harvesting occurred within a 200' distance to a stream channel (intermittent or perennial)

#### Database For Site Selection

Information needs and sources of information for the ownership classes are listed below.

#### **Information Needs:**

1. Total volume of timber harvested, by ownership, for the study area and period in time.
2. Sale specific information for the study period.
  - a. volumes harvested by sale or cutting unit
  - b. method of harvest

- c. identify sale related road construction
  - d. method of site preparation
  - e. soils and/or parent material
  - f. status of sale, i.e., opened or closed
3. Sale maps with legal description of section,  
township and range.

Sources of Information by Ownership:

**U.S.F.S**

Flathead National Forest Supervisors Office  
Kalispell, MT

**State Lands**

Department of State Lands, Forestry Division  
Missoula, MT

**Non-Industrial Private**

Department of State Lands, Forestry Division  
"B" Hazard Reduction Agreement Files

**Plum Creek Timber Company**

Dept. of State Lands, Forestry Div.  
Master Hazard Reduction Agreement Files

Plum Creek Timber Company, Kalispell Unit  
& Clearwater Unit - Swan Office

Once a complete list of sales for the study period and Basin had been compiled, sales which did not meet the site-selection criteria were eliminated from the audit pool. Using available maps, sales were screened to meet the 200-

foot-to-stream channel criteria, and verified either by phone contact with the appropriate managing office or by field-checks.

Those sales which met all of the criteria were summarized, by ownership, in a spreadsheet format. The respective Map Unit (MU) or Landtype (LT) for each sale was identified using the "Flathead Country Land System Inventory". These MUs identify soils and slopes and make it possible to assign a hazard class to each sale.

#### Ground-Truthing Site Selections

A sub-sample of sites were visited in advance of the field teams to verify that they met the site selection criteria. About 20 percent of all selected sales were visited. Most of these site visits were to Non-industrial Private sales as these were the sites for which information regarding the actual harvesting activity and proximity to a stream channel was least known.

#### **TEAM SELECTION**

Audit teams were selected in the following manor:

1. Names were solicited from participating member organizations in the Flathead Basin Cooperative, as well as from organizations and groups which have expressed an interest in management of the resources in the Basin.
2. Audit team member selection criteria included a familiarity with BMPs or interest in working with

them and knowledge and experience in one of the following disciplines: forestry, soils, hydrology, engineering, and/or fisheries.

3. Names on this list were organized into 5 groups, based on individual's field of knowledge. A random selection of one individual from each group, to assemble each team, was conducted. This was continued until 3 teams, each with 5 members, were assembled.
- 4 Each team was structured to include at least one professional who had participated in the 1988 EQC BMP assessments. This provided each team with an individual with some level of familiarity with a project of this type. The intent was to build a link of rating consistency between the two studies.

Table 2 displays a list of the audit team participants and their respective disciplines.

## **THE PROCESS**

### Rating Forms

The Department of State Lands' "DSL Forest Evaluation Worksheet", was the basis for the form we used for the BMP assessment (Appendix A). Some changes were made from the form used in the EQC's 1988 study, but these were only in general organization and additions to incorporate the amended BMPs resulting from that study.

Table 2. Timber sale audit teams.

**TEAM 1**

GEORGE WILSON	SILVICULTURIST	FLATHEAD NAT. FOREST
FRANK NETHERTON	ENGINEER	PLUM CREEK TIMBER
DEAN SIRUCEK	SOIL SCIENTIST	FLATHEAD NAT. FOREST
DON ALLEY	CONSERVATION	TROUT UNLIMITED
VITO CILIBERTI	HYDROLOGIST	BLM
SCOTT RUMSEY	FISHERIES BIOL.	FISH, WILDLIFE & PARKS

ALTERNATES: DENNY SIGARS FOR FRANK NETHERTON

**TEAM 2**

JIM LEHNER	SILVICULTURIST	PLUM CREEK TIMBER
JEFF COLLINS	SOIL SCIENTIST	DSL DIVISION OF FOR.
TOM WEAVER	FISHERIES BIOL.	FISH, WILDLIFE & PARKS
WALLY PAGE	HYDROLOGIST	FLATHEAD NAT. FOREST
ROBIN MAGADDINO	CONSERVATIONIST	AUDUBON SOCIETY

ALTERNATES: STEVE ROBBINS FOR JIM LEHNER  
ROD ASH FOR ROBIN MAGADDINO  
PHYLLIS SNOW FOR WALLY PAGE

**TEAM 3**

DEBBIE MANLEY	SILVICULTURIST	FLATHEAD NAT. FOREST
AL SORENSON	ENGINEER	FLATHEAD NAT. FOREST
STEVE TRALLES	HYDROLOGIST	WATER QUALITY BUREAU
MIKE ENK	FISHERIES BIOL.	FLATHEAD NAT. FOREST
BILL SCHULTZ	HYDROLOGIST	DSL DIVISION OF FOR.
KEITH ENGBRETSON	FORESTER	MONTANA LOGGING ASSOC.

ALTERNATES: BILL BASKO FOR DEBBIE MANLEY  
KIT SUTHERLAND FOR STEVE TRALLES

Recognizing that these new BMPs were not available prior to 1988, they were identified as separate line items on the rating form and will serve as baseline data for future assessments of BMPs.

## Field Work

Prior to actually performing any timber sale audits, the teams were gathered for a one day "Training Audit", which was conducted on May 30, 1989. The trial was held in the Tally Lake District of the Flathead National Forest and provided an opportunity to introduce the process of field assessment of BMPs and provide team members some hands-on experience and time to become familiar with the rating forms and evaluation procedures.

Procedures for evaluating a site were presented to all teams and teams had a chance to conduct evaluations on the same 2 timber sales. At each sale, teams were asked to share their results of these evaluations with the entire group. Discrepancies in ratings between groups were identified on each site and discussions were held in an attempt to standardize rating methods. The goal was to initiate a consistent method of addressing the practices on a sale, and then carry those methods through the duration of the field work.

For the remainder of the regular field season a field coordinator accompanied each team to each timber sale and worked to facilitate discussions within groups, and maintain rating consistency.

Teams were scheduled to audit approximately 18-20 sites, which required spending 8 days in the field. Table 3 summarizes the field schedule for each team.

Table 3 - The Flathead Basin Timber Sale Audit Schedule

TEAM 1				
<u>DATE</u>	<u>AUDIT #</u>	<u>SALE NAME</u>	<u>OWNERSHIP</u>	<u>DRAINAGE</u>
JULY 13	1.	GOAT ROT	STATE	SWAN
	2.	LOWER CILLY CREEK	STATE	SWAN
JULY 14	3.	ELK-COLD CREEK 5-28,29	USFS	SWAN
	4.	MISSION BUTTE #25	USFS	SWAN
JULY 27	5.	<b>NAPA GOAT #4</b>	USFS	SWAN
	6.	DEAD ON IT'S FEET	PC	SWAN
	7.	GOAT CANYON	PC	SWAN
JULY 28	8.	UPPER MCGINNIS #23	USFS	N.FK
	9.	WOODS BAY	PC	LAKE
AUG 2	10.	DUNN TEPEE #4	USFS	TALLY
	11.	STAR SHEPARD #22	USFS	TALLY
	12.	<b>(STAR MEADOWS)</b>	NIPF	TALLY
AUG 3	13.	NINKO MILLER #6	USFS	N.FK
	14.	(WHITEFISH RIVER)	NIPF	WH.FISH
AUG 4	15.	MOUNT CRK OSR #16	USFS	TALLY
	16.	BROWN MEADOW LPP	PC	TALLY
	17.	(BROWN MEADOW)	NIPF	TALLY
AUG 17	18.	<b>LOWER TAMARACK</b>	PC	TALLY
	19.	G. BRANCH II	PC	TALLY
	20.	WELCOME PICKLES	PC	TALLY

TEAM 2				
<u>DATE</u>	<u>AUDIT #</u>	<u>SALE NAME</u>	<u>OWNERSHIP</u>	<u>DRAINAGE</u>
JULY 6	1.	EWING DOG III & EXT.	STATE	STILLWTR
	2.	SWIFT-ANTICE #7	STATE	STILLWTR
JULY 7	3.	<b>LOWER TAMARACK</b>	PC	TALLY
	4.	A-B LODGEPOLE	PC	TALLY
	5.	BERNARD FLAT	PC	TALLY
JULY 10	6.	BILL CREEK #2	USFS	TALLY
	7.	LOGAN FALLS #4	USFS	TALLY
	8.	<b>(STAR MEADOWS)</b>	NIPF	TALLY
JULY 11	9.	STOPHER GOFOR #3	USFS	SWAN
	10.	SWEET MARY #12A	USFS	SWAN
JULY 31	11.	RIVERSIDE CANYON #10	USFS	S.FK
	12.	CIRCUS PEAK #14F	USFS	S.FK
AUG 1	13.	<b>NAPA GOAT #4</b>	USFS	SWAN
	14.	HUNGRY BEAR	PC	SWAN
AUG 22	15.	STONER CREEK #40	USFS	LAKE
	16.	(PABLO-ASHLEY CRK.)	NIPF	LAKE
AUG 23	17.	LION FLAT	PC	SWAN
	18.	JIM CORNICE	PC	SWAN

Table 3 (continued)

## TEAM 3

JULY 17	1.	NORTH FACE #4-4A	USFS	TALLY
	2.	SANDERS HAND #27	USFS	TALLY
	3.	<b>(STAR MEADOWS)</b>	NIPF	TALLY
JULY 18	4.	TERRACE HILL #14	USFS	MID.FK
	5.	MIDDLE FORK LP #21	USFS	MID.FK
AUG 8	6.	SOUTH FORK COAL CRK	STATE	N.FK
	7.	COAL RIDGE #21	USFS	N.FK
	8.	UPPER COAL #5	USFS	N.FK
AUG 9	9.	<b>NAPA GOAT #4</b>	USFS	SWAN
	10.	WEST JIM	PC	SWAN
AUG 15	11.	<b>LOWER TAMARACK</b>	PC	TALLY
	12.	RED CLEAR	PC	TALLY
	13.	SOUTH REDGATE	PC	TALLY
AUG 16	14.	HOLLAND PIERCE #6	USFS	SWAN
	15.	OWL ONE QUARTER	PC	SWAN
SEPT 6	16.	SQUAW CAMP	PC	TALLY
	17.	BROOK EAST	PC	TALLY
SEPT 7	18.	SWAN RIVER	STATE	SWAN
	19.	SOUTH COLD	PC	SWAN
	20.	<b>(SALMON PRAIRIE)</b>	NIPF	SWAN

## ABBREVIATIONS USED:

USFS - U.S. FOREST SERVICE  
 STATE - DEPT. OF STATE LANDS  
 PC - PLUM CREEK TIMBER COMPANY, INC.  
 NIPF - NON-INDUSTRIAL PRIVATE FOREST LAND  
 LAKE - LAND ADJACENT TO OR DRAINING INTO FLATHEAD LAKE  
 MD.FK - MIDDLE FORK OF FLATHEAD RIVER  
 TALLY - REGIONAL DRAINAGE AREA WEST OF KALISPELL/WHITEFISH,  
 INCLUDES ASHLEY CREEK.  
 SWAN - DRAINAGE AREA ULTIMATELY REACHING SWAN LAKE  
 N.FK - NORTH FORK OF FLATHEAD RIVER  
 S.FK - SOUTH FORK OF FLATHEAD RIVER

NOTE: SALE NAMES IN BOLD PRINT ARE THOSE THAT WERE USED IN THE RATING CONSISTENCY COMPARISON AMONG TEAMS.

Three timber sales were designated "comparative" sales. Each team rated these same 3 sales throughout the course of their field work to provide some data on how teams compare to one another with respect to assigning ratings to BMP application and effectiveness. This information is discussed in greater length shortly.

The field routine consisted of meeting at some central location on the morning of the field day. Teams generally traveled together, in one vehicle, to the audit site. A field-coordinator accompanied each team to facilitate participation by all members, stimulate discussion, and record field data on the designated rating forms. This individual also monitored consistency in ratings from site to site and between teams.

On the site, teams were provided maps and audit forms and briefed by a representative of the land ownership which was audited. The representative provided the teams with background information on the silvicultural prescription, timing, and associated practices relating to the entry we evaluated.

Team members were encouraged to stay relatively close together while walking the site, to the extent possible, to stimulate discussion of problems as they were observed. This also helped in resolving difficult ratings during the completion of the rating form later.

Teams typically spent 1-2 hours surveying the condition of a completed timber sale. Beginning in the riparian areas, teams worked their way through these areas noting the condition of the "streamside management zone" (SMZ). From the SMZs, teams worked toward portions of the sale which were potential contributing areas for sediments to stream channels. These included any skid trails, fire lines, road

surfaces or tributaries to the main channel. All stream channels and potential wet areas, including ephemeral draws, were inspected for evidence of washing or sediment transport. Although a thorough coverage of the entire sale acreage was desired, it wasn't always obtainable due to large areas and limited time. Teams concentrated on the riparian areas which are recognized as most critical to soil and water protection.

Inspections focused on the applicability of practices used, based on the "needs" of a site. The needs of a site were subjectively evaluated by a combination of the physical site characteristics (i.e., the potential for erosion), the silvicultural prescription and selected harvesting system. Other considerations included "delivery potential" to stream channels, and whether these activities contributed to increased efficiencies for sediment transport off-site. If increased efficiencies were observed, then it was generally felt that other practices should have been used to mitigate this.

In addition, interpretation of the effectiveness of the practices used in preventing water quality degradation was rated. This was assessed by observing the amount of surface erosion now occurring, the probability of delivery to a stream channel and the extent of area over which it was occurring. Most sales inspected were nearly 2 years old, which diminished the likelihood of further impacts, and

meant most erosion, if any, had already occurred.

Therefore, team members had to look for evidence of past erosion, such as sediment detention behind woody debris, and erosion pavements from which the fine soil fraction had been removed.

Upon completion of the inspection, and while still on the site, a team gathered to discuss their observations. Each team completed one rating form per site. The field coordinator acted as field recorder and discussion moderator, read through each practice and asked for suggestions on assigning a separate rating value for both "application and effectiveness". Upon obtaining ratings on the last practice, the coordinator summarized the general overview of the ratings given, to provide one last time for additional comments. Each practice received a subjective rating on 2 variables, "application" of the practice and it's "effectiveness", with values assigned ranging from 1 through 5. The meanings of these values can be found on the rating form in Appendix A .

#### **RATING OF BMPs**

The on-site assignment of subjective, qualitative BMP rating values by an interdisciplinary team is a complex process. It relies on successful interactions among a number of professionals with sometimes conflicting objectives, differing opinions and experiences working with BMPs. To arrive at a consensus rating for this process

requires that individuals pool their knowledge and experience in natural resource management. Compounding the complexity of the process is the variation in site conditions and silvicultural treatments from site-to-site, resulting in teams rarely viewing the same set of circumstances. With no two sites alike and vaguely defined conditions associated with the ratings scale, the process provided an opportunity for a considerable amount of individual interpretation. Measures were taken to control this variability and quantify it.

The "calibration audits" provided an opportunity for individuals and team members to become familiarized with how these numerical ratings should be assigned to reduce some of the subjectivity and variability between ratings within teams and across teams. In addition, the exercise was necessary to establish a process consistent with that of the EQC assessments. Additional criteria were reviewed at this meeting to assist teams in the assignment of the various rating values.

#### Application of Practices

Practice application was rated with respect to the intent of each BMP. To establish the application rating, several considerations are blended into one rating number.

Before teams could assign a numerical rating for each practice on the audit form, they considered the "need" for each practice to mitigate erosion. If a need was not

identified, the practice received a Not Applicable (NA) rating. The following questions helped to identify "need":

1. What was the erosion potential of the site prior to disturbance, considering site conditions such as soils, slope, topography, vegetative cover, soil moisture and prior management activity?
2. How did that potential change with the proposed management activities, i.e., road construction, timber sale prescription, landing and skid trail location?

The actual assessment of the erosion mitigation "needs" of a site were based on the following:

1. Observation of the magnitude and extent of erosion which had or was presently occurring.
2. Professional judgement of the perceived potential for erosion to continue.

Once it was established that erosion mitigation measures were needed, teams evaluated the adequacy of the practices which were applied. This involved reconsidering items #1 and #2 above to determine what the appropriate practices should have been to address these needs. Further considerations included:

3. Establishing what a preferred practice might have been to completely mitigate any erosion.
4. Assessing the economical and logistical limitations associated with applying that

practice.

5. Balancing items #3 and #4 to identify a practice that would prevent impacts to soil and water and still meet the intent of the BMPs.

The actual assignment of a rating value involved comparing what the teams identified as the "correct" application of practices, from #5 above, to the actual practices which were conducted. At times, this required teams to return to the documented BMPs to attempt to clarify a BMP's intent, either specified or implied.

The following information summarizes some of the special considerations associated with each of the 5 rating values.

#### **5 - Operation Exceeds Requirements of BMPs**

This rating was assigned to practices which demonstrated additional care or special treatment to mitigate erosion, beyond that which is specified or implied in the BMP. This may be reflected in the areal extent and frequency that a practice was applied, or in higher standards of construction for the erosional preventative features.

A practice was considered in relation to the accomplishment of silvicultural objectives. For example, a 5 was not issued in cases where an extremely large streamside management zone was left intact for wildlife considerations.

#### **4 - Operation Meets BMP Requirements**

The practice met the intent of the BMP and the frequency and standards of application were deemed sufficient to mitigate erosion. A very limited amount of erosion was observed and soils were determined to be stabilized. A team would generally not feel a need to offer recommendations for alternative practices..

#### **3 - Minor Departure From Intent of BMP**

Generally, this rating was used in cases where an alternative practice should have been selected and practices should have been applied with a higher standard and/or frequency.

Erosion was exceeding that which is acceptable under the intent of the BMP and/or the risk of potential erosion was judged to be high enough to justify improved practice application.

The term "minor" can be interpreted to mean a departure of relatively small magnitude distributed over either a localized area or broadly over an entire sale area and where a potential for impact has been identified as being low. A "Minor" may also be interpreted to be a larger magnitude of departure applied over a very limited area.

"Minor" ratings also commonly applied to circumstances where the level of required protection for the resource was sufficiently low. It is possible that a practice may not

have been applied at all, and yet it received only a "minor departure" because the needs were judged to be low.

## **2 - Major Departure From Intent of BMP**

"Major" departures were those practices with departures which were large in magnitude and with an increased frequency of misapplication, and displayed a greater potential for damaging the soil and water resource.

Extensive erosion was generally observed either in or immediately adjacent to stream channels, or sediment was observed moving on-site in such a way that the probability of sediment reaching the streams was high.

## **1 - Gross Negligence**

This rating applied to those instances where the risks to soil and water resources were most obvious and yet no evidence existed to indicate that practices were altered to provide for resource protection. Ratings were influenced by the actual departures observed, their magnitude, the areal extent of the practices, and the number of opportunities which existed, on a given sale, to apply a specific practice.

In general, the number of opportunities to apply a particular practice were a function of the amount and location of road construction, the acreage of the harvest, and the proximity of harvesting or equipment operation adjacent to stream channels or wet areas.

Stream crossings are an example of this variable. A sale that has only one designated stream crossing associated with it, and that one location has a poorly constructed crossing could be rated as a "major" departure. This is because the sale provided limited opportunities to apply the practice, and in that one spot where it was applied, it was not adequate.

In some situations the only difference between a "minor" and "major" departure was the location of each practice within the given sale area, and how that location influenced the potential for impacts to soil and water resources. Teams found the assignment of a single rating value to represent the level of BMP application across the entire sale area to be difficult at times. This was particularly noticeable in situations where the physical site characteristics varied considerably across a site.

#### Effectiveness of Practices

This rating scale asks the question: "Has the application or misapplication of a particular forest practice increased the likelihood of, or actual occurrence of, surface sediment in the stream channels?"

The site selection criteria requirement - that all sales sampled have harvesting activity within approximately 200 feet of a stream channel - was intended to provide a look at only those sales with a higher likelihood of impact

to water quality. However, we were not assessing direct impacts to water quality.

Impacts were defined as increased soil erosion because of disturbance to soil surfaces and the development of more efficient systems of sediment conveyance which contribute to or increase the likelihood of sediment reaching the stream channels. Impacts were not linked in any way to Montana's water quality standards, protection of any beneficial use, or assessed based on any physical measurements of the stream channel itself, such as measurements of suspended sediments or embeddedness. This type of quantitative information would be difficult to link directly to logging practices.

Teams observed several sites on which livestock grazing impacts were clearly contributing a proportionately greater amount of sediment due to stream bank damage, than any harvesting activity on-site. However, this did not prevent teams from rating forest practice effectiveness on these sites. Team members felt that they could adequately separate the impacts associated with each of these land management activities at the level which this methodology is designed to address.

We made the assumption that prevention of material eroding down-slope was generally adequate protection of the soil resource, but the decision on what rating to assign the practice contributing to this departure was dependent on

factors which would influence it's ability to reach a stream channel and ultimately leave the site.

Some of the factors considered included:

1. The network of existing channels or surfaces of conveyance on-site, i.e., roads or skid trails.
2. The proximity of the disturbed soils to these channels or surfaces of conveyance.
3. The present condition of the vegetative cover and the perceived ability of the site to stabilize.
4. The area of soil disturbance.
5. Whether the soil was determined to be in transit downslope to a channel.
6. Topography and slopes providing energy for transport.
7. Size and effectiveness of vegetative buffer below the disturbance.
8. Evidence of soil in stream channels, linked to forest practices.
9. Evidence of rilling, gullying, or the presence of an erosional pavement indicating fine textured soil particles had been transported.
10. Evidence of sediment detention trapped by woody debris, either in channels and riparian areas or in upland locations.

The consideration and weighting of these factors in team discussions determined the rating which a practice received with respect to impacts.

The following summary, by rating value, presents a general description of the conditions which warranted a given rating. These were determined from a review of the comments on the audit forms.

**5 - Improved protection of resources over pre-project conditions**

This rating was used in situations where either natural erosion or erosion from a previous entry was mitigated by practices conducted on the audited sale.

**4 - Adequate protection of soil and water resources**

There was little evidence of erosion taking place and low probability that any would occur in the future. Probability of any sediment reaching the stream channel from practices was determined to be low.

**3 - Minor and/or temporary impacts on soil/water resources.**

Erosion occurring on-site as a result of the forest practices. Sediment has been transported on-site and the majority is presently being trapped there by terrain, debris or vegetation. The probability of continued erosion is low. Soil disturbances may be excessive in locations and may be reaching channel. The amount of sediment contribution to streams is not viewed as significant in the context of this sale.

This rating was also given when areas of soil disturbance showed minimal evidence of transport on-site, yet the disturbance was positioned in such a location that it was a potential threat to the stream channel under the force of gravity alone.

Low gradient stream channels and their limited ability to move sediment off-site was also a factor in this rating, as was the ability of a site to stabilize the sediments. Improved practice application would have prevented these impacts.

## **2 - Major detrimental impacts, primarily short-term**

Significant amounts of erosion were occurring on-site either immediately adjacent to a stream course or on contributing surfaces, such as a roads. Direct contribution of sediment into the stream channel was observed at unsatisfactory levels, or the risk of delivery was so great that it was judged only a matter of time before it was realized.

Soils would not be stabilized by the following season of activity. Streambank and channel damage resulting from harvest activity was observed on-site.

Short-term recovery was interpreted to mean site stabilization within 2 - 4 years following completion of the operation. Corrective measures were needed to mitigate the erosion.

**1 - Major detrimental impacts, damage extensive, recovery expected to be slow.**

Similar to #2, but the difference was the estimated time required for adequate stabilization of soil.

This rating process rarely resulted in unanimous agreement on rating values, but a majority of each team frequently agreed on the scores which were assigned. In a few cases, team members were split or indecisive and a tie breaking vote was called to arrive at a rating.

Certain site characteristics were noted on sales in which a consensus was difficult to reach. Older sales commonly didn't give clear indications of the impacts which may actually have occurred immediately following disturbance. Healing of the soil surface and revegetation on these sites made assessments of surface erosion difficult. Stream channels which were poorly defined also produced more disagreement over the need for protection and resulted in a greater diversity of opinion in the ratings.

For the most part, if practices were adequately applied, the effectiveness in protecting the resource was also adequate. This close correlation is reflected in the RESULTS section (Table 5). On several sites, practices received differing ratings for application and effectiveness, which did not support the direct link between these two variables. Concerns were expressed over what

these cases might imply. Two of these situations were observed:

1. An adequately rated practice application which results in an inadequate protection of resources may point out at least two concerns:
  - a) The BMP language has not been specific enough in addressing site conditions which are more erodible than others. What may be considered adequate on one site, for practice application, may be inadequate for another more sensitive site. Teams viewed sites on highly erodible soils that reflected obvious care in planning and execution, and yet the results were impacts to soil and water.
  - b) It may illustrate the trade-off which is made between managing lands for resource production and the minimizing of non-timber resource impacts.
2. Practices which were needed and inadequately applied, and yet no impacts were observed. This could indicate:
  - a) Incorrect interpretation of BMP language, for which the owner was fortunate not to have experienced a combination of circumstances that would produce an observable impact.
  - b) Site erosion potential existed but was not

judged sufficiently high to call an impact.

This BMP rating process is highly subjective, and could be significantly improved with work on developing rating scales which provide general guidelines for field application by assessment teams. There is a need to provide some standardization to this process without ignoring the input of professional judgement.

There may be other alternative rating scales or descriptive terms which may be less open to a wide array of interpretation. In addition, since BMP assessments will be conducted in the future utilizing different personnel, it might be advantageous to narrow the range of interpretation so that one could be more assured that a rating of a "3" from the FBC study of 1989 would carry the same meaning as a "3" in some future study.

#### **DISCUSSION**

Much of the information gathered during this study is qualitative. Nonetheless, it can be valuable in understanding not only how the process was conducted, but for guidance in future studies and interpretation of results.

This section presents a summary of observations and suggestions made in the field by audit team members, and others, including myself, in regards to all aspects of the study. The section is divided into 7 sub-sections

addressing different components of the BMP assessment process.

### 1. Atmosphere of Participation

Studies which seek to examine the possible inadequacies of resource management practices and identify areas for improvements are often viewed as threatening to individuals and organizations in a number of ways.

Agencies and organizations may view them as costly in terms of a commitment of time and may view any findings which indicate a less than adequate job as possible "fuel" to ignite a movement toward forest regulation. Individuals whose work is being reviewed during the process may harbour fears, real or perceived, of potential threat of disciplinary action from management, or may even relate study outcomes to long term job security. Many of the individual sale administrators seemed to have only a vague idea of the intent of the study. Even though explanations were provided, some appeared to be uncertain of their role and purpose and possibly more uncertain of the support which they had from their upper-management. Defensive postures during discussions, and a reluctance to admit that a choice of practices might not have been the best approach, acted as barriers to obtaining answers or moving forward with discussions.

The situation was difficult for many of the administrators. Although they were not directly involved in

assigning rating values, the audit team members occasionally had to rely on administrators' input to weigh decisions on a rating. Questions regarding the practicality of certain practices on site or the timing of practice application were frequently directed to the administrator. Their response could influence ratings.

Nobody likes to receive poor performance grades, for they typically result in reduced monetary compensation or opportunities for advancement. For a sales administrator, bad ratings could be viewed as threatening if management doesn't send a clear message to the contrary. For those administrators who openly and honestly shared information and admitted that unforeseen problems had occurred, and that practices could have been improved, your honesty and professionalism was truly appreciated by the team members and myself.

If managers in this cooperative effort want a complete and accurate report of the level and effectiveness of BMP implementation, then there should be a formal communication from management to the support personnel explaining the project's objectives and soliciting full support from the necessary staff personnel. This was lacking on this study and in some areas may have been beneficial in improving the cooperation and any educational benefits with respect to BMP application and effectiveness which may have been derived.

## 2. Database and Site Selection

The objective to provide a comparison of the audit results in the Flathead Basin to those of the EQCs 1988 study restricted our choice of timber sales to those which met the previous study's site selection criteria.

Timber sale criteria and the associated information needed for the study were submitted to each ownership group, except the Non-Industrial Private whose data were provided by the Department of State Lands. All management activity information was returned to us in different formats, and we screened the information for necessary data.

For each ownership, a "pool" of timber sales was assembled to serve as a base for site selection. The following factors may have potentially influenced the site selection process by reducing the number of timber sales available for audit. In turn, these factors may have influenced our ability to accurately sample the population of forest practices. These items include:

1. The cooperation of the participating organizations in sharing their records.
2. The format, accuracy and completeness of the database available or provided by each ownership.
3. The number of timber sales in each ownership which met all of the study criteria.
4. The willingness of the non-industrial ownership to participate in the study.

Of the items listed above, #2, #3 and #4 directly influenced the site selection process by limiting the total available sites from which to select, limiting the use of the random sampling process, and introducing bias into site inclusion for the non-industrial private ownership group.

For each of the 4 ownership classes there were unique challenges in compiling a list of qualified timber sales to sample from. The following sub-sections discuss those challenges.

#### A. USFS Flathead National Forest

A list of timber sales on the Flathead National Forest was provided by the Forest Supervisor's office and included all timber sales which were "closed" between 1986 and the fall of 1988. In addition, 2 maps of each sale were provided - sale area and slash plan. The list provided 60 sales with contract number, contractor, sale name, and map number.

Some requested information was not provided due to limitations in the Flathead Forest database. Information not provided included the timing of harvest activity by cutting unit, acreage of cutting units, volume of timber harvested by cutting unit, silvicultural treatment information and road construction information. The maps did provide the general information for determining the "distance to stream channel" criteria, and identified the planned treatment and yarding method, new road construction,

and in a few cases provided summary tables for acreages of cutting units, while others were estimated.

This format involved a considerable amount of time in handling and summarizing data, which were later found to be incomplete. Some flawed assumptions were made at the Supervisor's office concerning the "age" of the harvest activity for the list of 60 "closed" timber sales. Many of the 60 sales were found to be too old to meet the study criteria and had to be discarded from our pool.

Several cutting units met the age requirement but the road construction and sale layout could have been as much as 5 to 10 years old. This raised the question of whether our focus should be on more current roads and sale layout practices.

To continue the verification process, those sites which did meet the initial criteria of "age" had to also meet the distance-to-stream-channel requirement of 200 feet. Sale maps were scaled to measure the distance to an identified stream course. During the verification process with the District people and on the ground, it was learned that many cutting units which appeared to meet the requirement "on paper" were, in fact, more than 200 feet away from a stream channel in layout. This required that an alternate site be selected.

Between these two criteria - "age of harvest" and " 200 foot proximity to a stream channel", many of the 60 timber sales were disqualified from our sampling process.

"Open" timber sale contracts, with completed slash disposal on cutting units were proposed as possible substitutes to fill the voids of the lost sales. Time would not permit a complete reconstruction of the site pool to include all "open" sales with available cutting units. District people cooperated by providing a selection of these, known to have completed work, from which replacement cutting units were randomly selected.

For future studies of this kind it is suggested that the Flathead Forest database for site selection be refined to provide a more current listing of completed cutting units. The new listing would contain cutting units from both closed contracts and open contracts which have had their slash disposal completed. Comments were made by personnel at the District level, that information regarding the stage of completion of cutting units on open sale contracts is available through each District office. This information is current to within 6 months or less of any given point in time. This would enhance our pool of sites to select from and would serve both to avoid selecting sites which are too old to accurately assess practices, and may also provide more of the Forest's latest work with BMP implementation. In addition, much of the non-spatial

information which was summarized from maps might be available in report form, serving to reduce the costs associated with the data organization related to the site selection process.

#### B. Non-Industrial Private

The Non-Industrial Private ownership category had an inadequate database to identify sales meeting the study criteria. Many days were required to build a database and verify the information. It became cost-prohibitive to build a complete pool of candidates to choose from. Instead, an arbitrary target of approximately 50 timber sales was identified as a reasonable number from which to randomly select 5 sites. These 50 sales were identified using a computerized summary of completed slash hazard reduction "B" agreements, from the Department of State Lands (DSL). However, these 50 sites had not yet been confirmed to meet the 200 foot distance-to-stream- channel criteria, nor had the land owners been contacted for their permission for access to their property. These two factors which would contribute to further difficulties in selecting an adequate non-biased sample from this ownership.

The files of the signed slash-reduction agreements proved inadequate to provide information regarding "distance-to-stream- channel" criteria. As part of the signed "Slash" agreement, the landowner or contractor is asked to provide a map of the area to be harvested, with an

adequate legal description. Records indicated that maps were rarely provided by landowner or contractor, and the State Lands slash administrator did not always insist on one. More recent slash reduction agreement forms now carry a data field to address water on site, but are not set up to identify stream channels. The recent House Bill 678, which addresses the administrative responsibility for the BMP assessments, and the subsequent program to be developed and administered by the DSL may provide procedures for documenting stream channels on non-industrial private lands and encourage a more complete database for future site selections.

Without accurate maps to check the "distance...", it was extremely difficult to qualify or disqualify these 50 sales without field checking or contacting each contractor or slash administrator for confirmation. Numerous phone calls were made to loggers and slash hazard administrators to draw upon their memory as to whether harvesting occurred adjacent to a stream. This proved equally inefficient as slash hazard administrators had difficulty, rightfully so, remembering what had occurred on a sale which was 2 years old. In addition, contractors may have several slash agreements open at any one time, making it difficult for an administrator to keep them straight in their own minds with respect to this requirement.

As a sale was determined to meet the eligibility criteria, attempts were made to locate landowners to obtain permission to access their property. Typically such attempts were met with reluctance and suspicion on the part of the landowners. Of the first 14 property owners contacted, 12 declined to participate for various reasons. This reluctance to participate reduced the pool of sites considerably. The first 2 sites for which permission was received, were landowners who were clearly proud to display their planning efforts, and "show-off" their work. It was becoming clear that as owners exercised their option of non-participation, any thoughts of this sample being non-biased were quickly dismissed.

As the inclination to eliminate this ownership from the study grew, sale reviews through DSL files and phonerwork continued until we had obtained 5 sales that met study criteria and for which permission was obtained. It should be noted that these represented the first 5 timber sales which met all of the study requirements and for which permission was granted. Random selection was not conducted for lack of an adequate sized pool to select from.

Other states which utilize BMP assessments, such as Idaho, have provisions in their forest practices legislation which provide agencies access to non-industrial private lands for monitoring of BMP compliance. Any future audits in this state should recognize the difficulties faced in

gaining participation from this sector, and the influence it has on achieving a representative sample of practices.

#### C. Plum Creek Timber Company

The number of timber sales from this ownership was influenced strongly, particularly in the Swan River drainage, by a backlog of scheduled slash treatment, preventing those sales from being included in our sample. At the time this database was compiled, over 30 % of all sales harvested between 1986 and the spring of 1989 were awaiting their slash treatment. A backlog of sales requiring their slash to be treated had resulted from two successive seasons of dry weather, which limited the window for slash burning.

This reduced the population of sales to such a low level that virtually all of the sales which met the criteria in the Swan River drainage were used, without a random selection process. In fact, so few were available that in order to achieve our target sample number from this ownership and drainage the slash treatment criteria was relaxed. This provided additional sales which had all harvesting completed and yet were awaiting a slash treatment prescription. Only sales which had slash prescriptions requiring no additional equipment operation on site, i.e., scheduled for broadcast burning, were included. This was necessary in order to provide a target of approximately 10 timber sales from this ownership and drainage in our sample.

Future BMP assessments which rely upon unbiased, representative sampling will depend on the assumptions made about the accuracy of the database information, the percentage of sales meeting the study criteria to the total sales harvested during the study period, and the willingness of all ownerships to participate.

#### D. Montana Department of State Lands

The "open" and "closed" timber sale contract files were used at the Forestry Division offices for compilation of a list of sales meeting the study criteria. The only problem encountered in assembling a pool of sites was the lack of harvest activity occurring within a 200 foot distance to the stream channel.

On several sales, cutting units were identified in the original "contract for bid" as meeting the proximity to stream channel requirement. However, the files indicated that upon completion of the environmental review by the soil scientist, hydrologist, and wildlife biologist, cutting units were either dropped from the sale or sale boundaries were adjusted. This resulted in pushing the activities beyond the 200 foot distance criteria. Sales which were conducted within this distance were frequently "salvage" operations for blowdown.

Other units located within 200 feet of a stream channel were usually too small to qualify in the minimum acreage and volume criteria. Few new roads were constructed as timber

on these parcels was yarded by cable to an pre-existing road resulting in only minimal disturbance of the land.

### 3. Team Selection

One of the criticisms expressed during the formation of the Cooperative was that the participants involved could not "objectively" answer the question they set out to address. The Cooperative was likened to the analogy of the "fox watching over the hen house" and suggestions were made to bring in organizations outside of the immediate land management ownerships to remedy this.

Audit team selection is open to the same criticisms. Originally it was proposed that teams be constructed in such a way that no individual rated his/her own work or rated work which was directly under their supervision. Understandably, this was intended to prevent bias or prejudice from entering into the rating values. Logistically this may have required that some individual not be allowed to rate particular drainages where the concentration of their previous work was located. Although this could have been arranged, the Cooperative expressed little concern over the bias which might enter the study as a result of this and expressed a greater concern in getting teams to audit practices across several drainages, instead of concentrating any one team in one drainage.

Ultimately, team members found themselves in the difficult position of rating their own agency or company's

work. Some team members were more comfortable with this task than others. However, on a few sales where a rating consensus was difficult to get, some team members openly admitted that their rating would be biased and even verbally expressed a desire not to participate in the rating of a particular practice. This seemed to indicate that even some audit team members were having difficulties with assigning rating values in an objective manner.

This occurred on only a few sites, but points out the trouble some individuals have in openly critiquing projects they have been associated with. Furthermore, timber sales where which a consensus was reached with the least discussion, were those in which no audit team member had a personal interest in the outcome of the ratings, i.e., the Non-Industrial Private lands.

The credibility of the audits can be enhanced by taking every practical step to avoid bias and to provide accurate assessments from which to build and improve on. If this means assigning team members to rate only practices on ownerships other than their own, then it is suggested those steps be taken.

#### 4. BMP Field Form

This section is subdivided into two sub-sections to address 1) the ability to adequately rate practices on the audit form, and 2) the rating scale and values used on the audit form.

#### A. Practices on the Form:

During the field work, audit teams found practices identified on the field forms that did not lend themselves to accurate, meaningful on-site assessment. Although ratings could be assigned, it was felt that the value assigned might not accurately reflect the practice application or effectiveness.

This situation was frequently seen with practices that were either administrative in nature, such as obtaining stream crossing permits, or related to the timing of the operation. Both of these situations involved an inability to observe the practice on-site or make a direct connection between practice and impact. On many of the sales, 2 years may have elapsed since the practice would have been implemented and any evidence of erosion or water quality related impacts would be difficult to assess.

Teams addressed the timeliness of activities on sites where an impact was observed but could not be attributed to any other practice. In other cases, if evidence didn't indicate any problem teams relied upon the memory of the sale administrator or their records. Sometimes the administrator wasn't always the one who actually administered the sale. Knowing only the month or the season of practice completion doesn't provide the kind of answers a question about timing is trying to ask. It may only tell us in broad terms what the potential risk of damage was. More

specifically, one would want to know more about the specific site conditions, i.e., soil moisture, soil frost, snowpack and/or climatic events experienced at the time of the activity. This approach was straying from the intention of "rating what we observe" and because of this, items of this type were frequently not rated.

Information related to timing of construction of road drainage features and other erosion mitigation measures are important and warrant inclusion in this process, but are not addressed properly in a post-harvest review. To adequately assess these practices and their impacts, one could conduct a separate review of these items on timber sales in-progress.

If this form is to be used in the future, items such as these should be either removed from the form or the information should be obtained from sources other than post-harvest field reviews.

Other items also posed difficulty in relation to their inclusion on the form or their wording. Generally, these were related to the question of "How do team members accurately assess forest practices on a given site, recognizing the intent of the BMPs and the diversity of site conditions, using a numerical approach?" This involves a clear understanding of the intent of the BMPs, and the importance or contribution of a given practice toward addressing that intent. Although that intent is not always

clear in the BMPs themselves, structuring the audit form so that there is a clear connection or cross-referencing ability between the form and the BMP document would be one important improvement.

In cases where the intent can be succinctly stated on the form either through language changes or additions, it should be done. Care should be exercised not to make the practices on the form more restrictive than the wording in the actual BMP itself or the form will not be measuring the same thing.

Several practices are identified in the following table, with comments for improvement. These practices frequently presented difficulties in interpretation for ratings.

Additional items suggested as possible improvements to the audit form include:

- 1) The separation of "system roads" from "temporary roads" in the rating process. In addition, the audit form should provide space for distinguishing between practices involving "new construction" and "re-construction".
- 2) Remove the streamside management zone (SMZ) practices from the Timber Harvest section and develop a separate section for all activities influencing the SMZ, i.e., roads, harvesting, slash disposal, and site preparation.
- 3) Provide a separate section to cover the practice of broadcast burning as a method of slash treatment. Within

Table 4. Existing Audit Form Language and Suggestions For Improvement.

<u>BMP SECTION</u>	<u>PRACTICE # and DESCRIPTION</u>
Construction	1. Cut and fill slopes at stable angle  Comments: Wording might be changed, although in it's present form it is almost verbatim to the documented BMP. Intent is unclear, could suggest room for BMP language improvement. Suggest reword to "proper angle" or "stabilized".
	6. Grass seeding completed  Comments: Might make practice more encompassing than just stabilization related to the act of seeding. Rating this items doesn't adequately address the complete stabilization of soil disturbances related to road construction.
Maintenance	4. Closed roads left in condition to provide adequate drainage.  Comments: Interpretation of the word "Closed" was reserved for roads with barriers to travel, while gated roads were considered "restricted". Suggestions included the use of the word "abandoned" instead. Needs a more-clearly defined intent regarding adequate drainage to rate this practice. After weathering for 2 years, one would expect less erosion than was observed on some and more drain features functioning.
Maintenance	5. Restrict use of roads during wet periods and spring breakup  Comments: Interpretation was with respect to the gating or posting with signs to restrict travel. Rating teams should concentrate on the need, and actual visible evidence of the practice on site. Focus should be on efforts aimed specifically at addressing soil and water resources and not wildlife, although they may not be

Table 4 (continued)

mutually exclusive.

Timber Harvest      3. Equipment operation in wet meadows  
and bogs avoided

Comments: At what point does interception of ground water, near the surface, constitute a departure? The intent is to prevent the development of a more efficient system of water conveyance downslope, although not stated in the BMP. This wording leaves some team members thinking in terms of soil displacement.

4. Skidding operation minimizes soil disturbance

5. Skidding operation minimizes soil compaction

Comments: For 4 and 5, teams were frequently not certain of what an acceptable level was.

May need guidelines developed by soil scientists as ratings were often deferred to them.

Treatment and  
Site Preparation      3. Operation done when soils are dry  
enough to minimize compaction and  
displacement

Comments: Remove the words "dry enough" as the frequency of equipment travel and the care in operating equipment can impact even dry ground. Would still need separate item to address the timing of activity, whether or not it would be assessed in a post-harvest BMP review. Provide guidelines for assessing these impacts. Some suggest that displacement and compaction should be split out separately.

5. Protection of SMZ during slash reduction

Comments: Add "and site preparation."

this category it was proposed that the following questions be addressed:

- a. Burn intensity too hot, resulting in soil erosion or riparian vegetation problems ?
  - b. Was the burn accomplished in a fashion to meet soil, water and riparian vegetation goals ?
- 4) Provide a location on the form to identify the average SMZ width.
- 5) Change title of section "Road Planning and Location" to "Road Planning and Design". Provide clarity in practice #6 by adding wording specifically addressing the rolling of the grade. Provide opportunity to rate the design, i.e., outslope vs. insloped/ditched and their effectiveness.
- 6) Remove the rating practice, "25' minimum SMZ maintained?" from the "Timber Harvest" rating section which utilizes an ordinal rating scale because this question is best addressed by a yes/no response. Some suggest removing the item altogether, which would be appropriate if item #4, above, were incorporated into the form.

Ideally, the development of a guidebook to compliment the audit form would serve to eliminate some of the problems in BMP interpretations. This could be done with either a photo guide or a more complete description of the BMP's intent. In the absence of that, any changes to the practices on the form should focus on clarifying the intent of the practice which teams are attempting to rate.

Other concerns regarding clarification of intent were of a more general nature. Teams were uncertain of the extent that practices should be applied to address soil erosion in upland locations. Some felt that if erosion is occurring and yet hasn't reached a channel, we should assess the ability of the site to stabilize itself. If sediment is being detached and transported on-site and the probability of it reaching the channel is relatively low, teams would assign a rating to the practice which they felt was needed to control the erosion. This varied from receiving a "3" if sediment was transported downslope to a "4" for no impact. Consistency in addressing upland soil erosion with this process is another area in need of clarification with respect to intent.

Comments from these audits can be important indicators of the need for improved clarity in the BMP language to improve the level of understanding and application in the field. It was generally felt that if the rating teams had trouble interpreting certain practices, field-personnel would have similar trouble implementing them.

#### B. Rating Scale:

The rating scale used variables "application" and "effectiveness", each with 5 possible values. The following section discusses comments and observations which were made concerning use of this scale for assessing BMPs.

1. Is there a need for more precise rating values in order

- to provide an objective assessment of practice application and associated impacts ?
2. Does the existing rating scale influence the manner that teams or individuals interact and arrive at consistent ratings, from site to site, particularly in the absence of any documented procedure ?
  3. If these values are left loosely defined and open to interpretation, will it significantly influence the repeatability of a study of this type and impair the ability to make comparisons of results between different studies ?
  4. Do the results give us the best kind of data necessary to improve the management of our forest lands for the minimization of nonpoint source pollution ?

The most frequent difficulty encountered in using the 5 point scale was in establishing the range of conditions or observations that could be associated with each of the 5 values. Even though general guidelines were discussed during the calibration audit, the wide variety of site conditions and practices required a considerable amount of interpretation in the field. Team members expressed a desire to have the scale of values more rigidly defined. Some of these feelings were a result of infamiliarity with the system, and as time passed and team members interacted and experienced a variety of situations, they developed the skills necessary to use the system effectively and with

improved consistency. Unfortunately, much of the field season passed before these skills were successfully developed.

Although a system which removes all professional judgement is not the answer, there are improvements which can be made to remove some of the subjectivity of this system and improve the consistency of applying this methodology.

The language used in the rating value descriptions was a source of some difficulty. The language uses negative connotations that can be somewhat threatening for some people. Phrases such as "major" and "minor" departures may be fine in a regulatory environment where practice compliance is the primary objective. Under the cooperative framework they may act as a barrier to assigning rating values which accurately depict the practice. Each of these terms have meanings which may be taken out of context and may cause individuals to shy away from using a number which contains such language, for fear of misuse of results. Attempts should be made to use terminology which does not carry such negative connotations, but instead points toward a more accurate description of the level of BMP application or effectiveness.

Another problem with the rating language is that no one can precisely define what constitutes a "major" or "minor" departure or impact. Team members develop mental pictures,

even though frequent reminders were given during team discussions to maintain a level of consistent interpretation. When an individual team member took a position that either a "major" or "minor" departure or impact had occurred, they sometimes found it difficult to support that opinion. Many times the burden of proof rested solely on the professional opinion of an individual during a discussion because no definition existed for the terms "major" or "minor". In fact, impacts may have occurred but have since been masked by the passage of time, leaving little evidence to support one's position.

Once team members were challenged on their opinions, they may not have been confident in their convictions, were placed in the minority or persuaded to change to a rating value which was less controversial. This was usually not the case when impacts were either still occurring or were so extensive as to warrant the use of the terms without hesitation. The terminology and their connotations and the lack of a clear distinction between the two terms tends to discourage individual participation. This was demonstrated by the time it took, on some teams, for someone to "stick their neck out" and put a rating up for discussion. This was most notable on sites where it was more obvious that departures in BMPs existed and the potential for considerable discussion was evident.

One alternative would be to remove the language that doesn't serve the interaction process well. Suggestions for language changes on the application scale include replacing wording such as "minor departure from intent of BMP" with "alternative practice or standards desired to mitigate erosion." and replacing "major departure" with "absence of necessary practices to mitigate erosion". It was also proposed that the rating for application termed "gross neglect of BMPs" be dropped from the form as it provides no additional value beyond the other ratings which are available.

Similar descriptive language could be developed for the "effectiveness" scale that would better define short- and long-term and clarify what might constitute a "minor/temporary impact", and "major impact".

Once the language was modified to a more functional level for interpretation in the field, a methodology should be developed for a more systematic approach to the assignment of a rating. This could be a simple outline of the necessary steps in the thought and observation process that are necessary to arrive at a rating.

The following list provides some questions and considerations for such a methodology:

1. Do site conditions and silvicultural prescription warrant the application of a certain BMP ?
  - a. Are practices being implemented ?

- b. What are the limitations to employing a practice ?  
Considerations include:
  - a. Physical limitations of the site
  - b. Silvicultural objectives
  - c. Equipment limitations
  - d. Economics
- 2. What is the quality of BMP implementation ?  
Considerations include:
  - a. Design standard or level of execution
  - b. Consistency of application
  - c. Frequency of application
- 3. Are BMPs minimizing soil and water impacts ?
  - a. Is the observed soil disturbance associated with timber harvesting or related activities ?
  - b. Attempt to quantify the area of disturbance focusing how much is localized vs. distributed over broad areas.
  - c. Is sediment reaching a stream channel ?
  - d. Has sediment been flushed off site as a result of the practice leaving an erosion pavement?
  - e. Will sediment reach a channel or leave the site in the future ?
  - f. How long will the observed erosion or the potential for erosion continue before stabilization occurs ?
  - g. What beneficial uses will be impacted by increases in sediment in a given stream reach ?

4. Are there questions regarding BMP interpretation and needs for revision ? Considerations include:
  - a. Clarity in the intent of the BMP
  - b. Adjustment of BMP language to reflect practices on difficult site types i.e., granodiorite vs. metasediment

These were questions that each team member answered at some point during the field audits but for which the form and rating scale proved inadequate to address in a direct and consistent manner.

A broader question which might be asked for future studies is "Does this rating scale, and associated descriptive provide the kind of data which is easily interpreted and most useful to assessing non-point impacts from forestry practices ?" Answers to this question might point to a need to a complete redesign of the ratings scale and procedures for assessing practices. Decisions regarding this should balance the importance of linking the data from future studies to those of the past against the potential benefits of gathering information which may be more valuable in describing watershed condition and nonpoint source pollution.

Instead of teams becoming locked up over interpretations of "major" vs. "minor", which occurred frequently, an improved field form might provide the direction necessary to consistently apply this methodology.

Such an improvement might lead to more meaningful and consistent data from site to site.

Another alternative rating guide for practice "application" would drop the "major" and "minor" distinction in favor of the following approach.

1. Is the practice necessary on this site? Yes/No
2. Was the practice adequately applied to mitigate erosion and protect water quality ? Yes/No
3. If No to Question 2, then check the appropriate box below that represents the approximate frequency or extent of the practice departure on-site?

_____	0 - 10 %
_____	10 - 40 %
_____	40 - 70 %
_____	70 - 100 %

With these specific questions to answer, team members will not only have a more systematic approach to assigning a rating by avoiding the connotation associated with "loaded" terms, but will also improve consistency in ratings from site to site. Further, these data lend themselves to statistical frequency analysis.

It is difficult to assess what impact rating assignments had on the outcome of the audits, or whether ratings might have been significantly different.

The recommendation of many was to put the results from the rating scale into two groups - those practices which

were adequately applied and effective and those which were not. If this were to be the extent of the analysis, then efforts at refining a scale to provide distinction between 5 rating values seem to be academic.

Efforts to standardize both the form and methodology should continue, as it appears that these assessments will become one vehicle for controlling non-point source pollution from forested lands in Montana.

Although we want to link the results of this study to previous efforts, the importance of the development of such a tool which will perform over the long-term, should not be underestimated. The system should be flexible enough to undergo changes as they become necessary while providing direct and consistent information to answer questions regarding the effectiveness of BMPs in controlling nonpoint source sediment production.

## 5. Field Work

The field work began with providing training in the uses of the assessment tool. While the "calibration audit" was a good opportunity to get out on the ground and apply the methodology, logistically it could not provide the kind of exposure to site variability which teams encountered during the field season. Nevertheless, exposure was necessary for improving the consistency of ratings from site-to-site. A slide presentation that captures some of this variation might be very valuable. The slides could be

viewed and discussed by audit teams to establish a framework for the uniform assignment of ratings.

On site, it was very important to cover as much ground as possible quickly. Any time saving short-cuts resulted in short-changing the thorough review of all practices. However, a suggestion for improvement in this area was to provide the ownership representative a list of general audit concerns so that he/she may direct teams to areas where these practices occurred.

Although teams were successful in covering 3 sales in one day, team members felt that 2 sales might have been a more realistic objective. Understandably, the effectiveness of their work and attention to detail declined in the late afternoon and early evening.

#### 6. Consistency in Ratings

Attempt was made to quantify the level of consistency in ratings among teams. BMP assessments on the same 3 sales were conducted by all three teams at different times throughout the field season. The 3 sales offered wide ranges of BMP requirements, application and effectiveness. Where BMPs were applied and effective, there was a high level of consistency in ratings among teams. Where levels of BMP application were less than adequate, consistency was also good.

The greatest differences in ratings occurred on sites that impacts were not as easily linked to specific

departures from BMPs. For example, one team felt that the road drainage was responsible for concentrating water and energy and contributing to surface erosion, where another team viewed timber harvest activities as contributing a greater impact. Both teams may have rated road drainage and timber harvest practices less than adequate, but the ratings for each of the practices were different.

For the comparison sites only, the number of rating values were reduced from 5 to 2. All scores of 4 or 5 were lumped together (adequate and effective or better) and all scores of 3, 2 or 1 were lumped together (inadequate and ineffective or worse). Table 4 illustrates team comparisons in ratings across the same 3 timber sales.

Using the simpler yes-or-no rating scheme, teams were actually fairly consistent. Teams 2 and 3 were very similar in their ratings on the Napa Goat and Private/Sinclair Creek sales. The disagreement between team 2 and team 3 on the Lower Tamarack sale was because team 2's misdirection on-site that resulted in their not seeing a road used during harvest and eroding badly because of poor drainage. Team 1 consistently scored the same sales more favorably than the other two teams.

The consistency seem among teams using the 2-value rating scale on the comparison sites might be a legitimate argument for using the 2-value scale for the entire audit process. Again, a team or person is usually able to judge

whether a practice is adequate or inadequate, but it is not so easy for 2 individuals to agree upon the magnitude of the departure or impact.

Another question of consistency involved that which occurs between sites. This involves the question of "Does a rating of a 3 on one practice on one sale carry the same meaning as a 3 on the same practice on a different sale ?" Although frequently similar, observations indicated it was not always the case. There seemed to be too many variables influencing a rating at a given point in time. The susceptibility of ratings to individual interpretation, although tempered by the interaction by the group and moderator, made placing practices from two different sales on the same rating scale difficult. These difficulties may point out subtle areas where further refinements in BMP language may be beneficial.

#### 7. Other Influences in Ratings

Many factors influenced the final rating value assigned to a practice. The use of interdisciplinary teams to conduct these audits brings together a diverse group of individuals with different understanding and interpretation of the BMPs. The dynamics of group interaction and the communication skills of individuals within the group can effect the rating values. Not all audit team members consistently took a professional and objective approach to the process. Most displayed consistency in their concerns

for the water and soil resources and that was reflected in the discussions of the ratings, regardless of the ownership evaluated. Opinions were not always volunteered freely. At times it was necessary to question team members individually to obtain his/her rating.

The performance of the interdisciplinary teams in the assignment of ratings varied at times but was generally regarded as very professional. Ratings were not influenced at the decision level where it was necessary to establish the "need" for a practice. Nor did teams generally have any difficulties in deciding if practices were applied or whether impacts had occurred. Problems in reaching a consensus were related to the "magnitude" of the departure and the impacts.

These differences and the eventual rating were a function of site conditions, the obvious nature of an impact, the rating scale used, the differences in perception of what needed protection, and the persuasiveness and determination of individuals in the group during discussions. These observations indicate that the reliability of the ratings are strongest when the 5 point rating scale is re-classified into two categories for each variable:

- Application:
1. practices applied
  2. practice not applied

- Effectiveness: 1. adequate resource protection
2. inadequate resource protection.

Age of the sale being reviewed may also influence ratings. Our study allowed for the examination of activities which occurred over previous years. After looking at a variety of different- aged sales the teams felt that age can have a significant influence on a team's ability to accurately assess the impacts resulting from management activities. Depending on the moisture conditions of the site, varying densities of vegetative cover can hamper efforts to identify impacts. The first runoff following the management activity is generally recognized as the most critical time for sediment production. Any observation conducted on a site with activities older than 1 year may result in missing some of the observable impacts. Some sales were considerably older than others and may not have received the same rating if audited nearer to sale completion.

Grazing impacts had the potential to influence a rating. Many of the sites had streambanks that were heavily impacted by cattle. Team members felt that an adequate distinction could be made between impacts associated with harvesting timber from those related to grazing. On sites where grazing impacts were not as severe, teams inspected the channel for evidence of sedimentation which was probably related to harvesting.

Table 5. Team comparisons of ratings.

PERCENTAGES OF PRACTICES					
APPLICATION			*	EFFECTIVENESS	
			*		
% RATING <sup>1</sup>	% RATING			% RATING	% RATING
< A SCORE	> OR = 4		*	< A SCORE	> OR = 4
OF 4			*	OF 4	
SALE NAME: NAPA GOAT #4					
TEAM #					
1	16	84	*	16	84
2	32	68	*	32	68
3	32	68	*	26	74
SALE NAME: LOWER TAMARACK					
TEAM #					
1	16	84	*	8	92
2	4	96	*	0	100
3	20	80	*	12	88
SALE NAME: PRIVATE/SINCLAIR CREEK					
TEAM #					
1	54	46	*	54	46
2	69	31	*	72	28
3	69	31	*	66	34

<sup>1</sup> The number 4 refers to the rating scale value, and represents an adequate level of practice application and effectiveness.

#### CONCLUSIONS

Future audits should review the site selection criteria for possible improvements in site sampling. This should include consideration of "new road construction" as a higher priority than "slash treatment completed" when establishing site selection criteria. This is because of both its greater capacity to influence water quality and the higher proportion of practices which it represents on the audit

process form. Also needed are adjustments in the "window" of time between completion of sale and practice review to capture the time period representing the greatest risk and most observable impacts to water quality. Other changes might include: field review of practices immediately following the first runoff season, or "in-process" reviews; if "slash completion" remains a criteria for selection then slash backlog should be reduced to some acceptable level before audits are conducted to insure a more complete "pool" from which to sample; using the silvicultural prescription to establish the intensity of harvest activity vs. the volume of timber removed per acre.

Although teams had difficulty on some sites with the BMP language associated with certain practices, in general it seemed sufficient to carry out these assessments. Some practices require more specifically defined intents so that foresters and equipment operators can understand why it is important to apply a practice. Instead of moving toward changes in the practices we have, we might first focus our efforts on education. For example, education regarding adequate drainage for open and closed roads and adequate number of drainage relief features for roads on specific soil types can provide improvements in BMP interpretation.

There are practices that could use elaboration in identifying intent. Specific problems with interpretation were encountered in the area of soil compaction and

displacement. Guidelines are necessary, not only for these assessments but for the operator and administrators to apply these practices within the intent of the practice.

This methodology is in it's infancy. Additional work is needed to develop the BMP assessments in the areas of: improving training of field teams in recognizing BMP departures and impacts prior to going on-site; modifying the field audit form to consider only those practices which can be visually inspected in the field; provide cross-referencing of practices on the field form to the State's BMP document; change the rating scale form and/or language and provide a guideline for field teams to distinguish among values, establishing in-process audits for those important practices that relate to timing of activities.

## **RESULTS**

This study was designed to address a number of questions:

1. What is the current level of BMP application in the Flathead Basin and how effective have those practices been in preventing sediment from entering stream channels?
2. How do the levels of BMP application and effectiveness compare with the results of the 1988 Environmental Quality Council's BMP study?
3. What specific categories of BMP implementation and

practices are contributing the greatest number of impacts? Where do improvements need to be made?

4. How does BMP implementation vary by ownership?
5. New BMPs provide for greater protection of the streamside management zone. Even though not officially considered in this audit, how would those practices have been rated if they were?

Three teams audited a total of 52 timber sales throughout the Flathead River Basin. Each team had an opportunity to assess practices and impacts across the entire basin.

Each timber sale audited potentially had 39 separate management practices to evaluate. Each practice was rated for the degree to which it had been applied and the degree to which the practice contributed sediment or increased the likelihood of sediment reaching surface waters.

Not all practices were applicable on every sale. In total, 1427 practices were evaluated for the application of BMPs on 52 timber sales, which is approximately 27 practices per sale.

#### **BMP PERFORMANCE IN THE FLATHEAD BASIN**

Four methods of analyzing the findings of these audits have been selected to address the first question:

- 1) Analysis of BMP application and effectiveness by percentages of the "total practices audited".
- 2) Analysis of the percentage of practices audited on

each ownership which are contributing to major and minor impacts.

- 3) Analysis of percentages of "timber sales" contributing to impacts.

#### Method 1 - Analysis by "Total Practices Audited"

About 2 percent of the 1427 practices exceeded the requirements of the BMPs; 88 percent met the BMPs; 7 percent were rated as minor departures; and 2 percent were rated as major departures and 1 percent were considered "gross neglect".

Similarly, 1427 practices were rated for effectiveness. Of these, less than 1 percent were considered practices which improved resource protection over pre-project conditions; 91 percent were rated as adequate resource protection; 7 percent rated as causing minor or temporary detrimental impacts; 2 percent were rated as causing major detrimental impacts, which were primarily short term; and less than 1 percent were evaluated as major detrimental impact, with extensive damage and long-term recovery.

Table 6 provides a summary, by individual practice, of the rating numbers assigned for each ownership. Appendix A provides a copy of the field rating form with the guide used to assign the values from 1 to 5.

Table 6. Summary of BMP ratings

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
ROADS - PLANNING											
1. MINIMIZE											
4 OF ROADS	NON-IND.PRIV	0	0	0	5	0	0	0	0	5	0
	PLUM CREEK	0	0	0	18	1	0	0	0	19	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	22	0	0	0	0	22	0
	TOTAL	0	0	0	49	1	0	0	0	50	0
2. USE EXIST.											
ROADS	NON-IND.PRIV	0	0	1	3	0	0	0	1	3	0
	PLUM CREEK	0	1	1	15	0	0	1	1	15	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	0	12	0	0	0	0	12	0
	TOTAL	0	1	2	36	0	0	1	2	36	0
3. APPROP. ROAD											
STANDARDS	NON-IND.PRIV	0	1	0	2	0	0	1	0	2	0
	PLUM CREEK	0	1	0	12	0	0	1	0	12	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	15	0	0	0	1	15	0
	TOTAL	0	2	0	34	0	0	2	1	33	0
4. LOCATION TO											
AVOID HAZARD	NON-IND.PRIV	0	0	1	1	0	0	0	0	2	0
	PLUM CREEK	0	0	1	11	0	0	0	0	12	0
	STATE LANDS	0	0	0	3	0	0	0	1	2	0
	USFS	0	0	0	11	0	0	0	0	11	0
	TOTAL	0	0	2	26	0	0	0	1	27	0
5. ADEQUATE SMZ											
PROVIDED	NON-IND.PRIV	0	0	0	1	0	0	0	0	1	0
	PLUM CREEK	0	1	0	3	0	0	1	0	9	0
	STATE LANDS	0	0	0	3	0	0	0	0	3	0
	USFS	0	0	1	7	0	0	0	0	8	0
	TOTAL	0	1	1	19	0	0	1	0	20	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
6. PERMITS FOR											
CROSSINGS	NON-IND.PRIV	0	1	0	0	0	0	0	1	0	0
	PLUM CREEK	0	0	0	4	0	0	0	0	4	0
	STATE LANDS	0	0	0	2	0	0	0	0	2	0
	USFS	0	0	0	7	0	0	0	0	7	0
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	1	0	13	0	0	0	1	13	0
7. AVOID LONG											
STEEP GRADES	NON-IND.PRIV	0	0	1	1	0	0	0	1	1	0
	PLUM CREEK	0	0	0	13	0	0	0	0	13	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	11	0	0	0	0	11	0
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	1	29	0	0	0	1	29	0
8. MINIMIZE #											
OF XINGS	NON-IND.PRIV	0	0	1	1	0	0	0	1	1	0
	PLUM CREEK	0	0	0	10	1	0	0	0	11	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	1	11	0	0	0	0	12	0
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	2	26	1	0	0	1	28	0
ROAD - DRAINAGE											
1. ADEQ.SURFACE											
DRAINAGE	NON-IND.PRIV	1	0	1	1	0	0	1	1	1	0
	PLUM CREEK	0	1	8	8	0	0	1	6	10	0
	STATE LANDS	0	0	1	5	0	0	0	2	4	0
	USFS	0	0	4	13	0	0	1	4	11	1
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	1	1	14	27	0	0	3	13	26	1
2. TIMELY											
INSTALLATION	NON-IND.PRIV	1	0	1	0	0	0	1	1	0	0
	PLUM CREEK	0	0	1	12	0	0	0	1	12	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	16	0	0	0	1	15	0
*****		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	1	0	2	32	0	0	1	3	31	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
ROADS - DRAINAGE											
3. DRAINAGE											
THRU SMZ	NON-IND.PRIV	0	0	0	0	0	0	0	0	0	0
	PLUM CREEK	0	1	3	3	0	0	1	3	3	0
	STATE LANDS	0	0	0	2	0	0	0	0	2	0
	USFS	0	1	3	6	0	0	0	2	8	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	2	6	12	0	0	1	5	14	0
4. PROPER XING											
INSTALLATION	NON-IND.PRIV	0	0	1	1	0	0	0	1	1	0
	PLUM CREEK	0	0	2	5	0	0	0	2	5	0
	STATE LANDS	0	0	0	2	1	0	0	0	3	0
	USFS	0	1	0	7	1	0	1	0	8	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	1	3	15	2	0	1	3	17	0
ROADS - CONSTR.											
1. STABLE CUT &											
FILL SLOPES	NON-IND.PRIV	0	0	1	0	0	0	0	1	0	0
	PLUM CREEK	0	0	1	12	0	0	0	2	11	0
	STATE LANDS	0	0	0	4	0	0	0	1	3	0
	USFS	0	0	0	12	0	0	0	1	11	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	2	28	0	0	0	5	25	0
2. HALT WHEN											
WET	NON-IND.PRIV	0	0	0	0	0	0	0	0	0	0
	PLUM CREEK	0	0	0	11	0	0	0	0	11	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	14	0	0	0	0	14	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	0	29	0	0	0	0	29	0
3. EROSION											
CONTROL KEPT	NON-INDPRIV	1	0	0	0	0	0	1	0	0	0
CURRENT	PLUM CREEK	0	1	0	9	0	0	1	0	9	0
	STATE LANDS	0	0	1	3	0	0	0	0	4	0
	USFS	0	0	0	14	0	0	0	0	14	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	1	1	1	26	0	0	2	0	27	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
4. CLEAR VEG.											
FROM FILL	NON-IND.PRIV	0	0	0	1	0	0	0	0	1	0
	PLUM CREEK	0	0	0	13	0	0	0	0	13	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	13	0	0	0	0	13	0
	TOTAL	0	0	0	31	0	0	0	0	31	0
5. OVERBURDEN											
PLACEMENT	NON-IND.PRIV	0	0	0	0	0	0	0	0	0	0
	PLUM CREEK	0	0	0	6	0	0	0	0	6	0
	STATE LANDS	0	0	0	2	0	0	0	0	2	0
	USFS	0	0	0	9	0	0	0	0	9	0
	TOTAL	0	0	0	17	0	0	0	0	17	0
6. GRASS											
SEEDING	NON-IND.PRIV	1	0	0	0	0	1	0	0	0	0
	PLUM CREEK	0	0	2	9	0	0	0	4	7	0
	STATE LANDS	0	0	0	3	0	0	0	0	3	0
	USFS	0	0	0	14	0	0	0	2	12	0
	TOTAL	1	0	2	26	0	1	0	6	22	0
ROADS -											
MAINTENANCE											
1. ROAD GRADING											
	NON-IND.PRIV	1	0	0	1	0	0	1	0	1	0
	PLUM CREEK	0	1	4	13	0	0	0	3	15	0
	STATE LANDS	0	0	0	5	0	0	0	0	5	0
	USFS	0	0	2	16	0	0	1	1	16	0
	TOTAL	1	1	6	35	0	0	2	4	37	0
2. FUNCTIONAL											
CULV./DITCH.	NON-IND.PRIV	0	0	1	0	0	0	0	1	0	0
	PLUM CREEK	0	2	3	8	0	0	1	4	8	0
	STATE LANDS	0	0	1	5	0	0	0	1	5	0
	USFS	0	0	0	16	0	0	0	1	15	0
	TOTAL	0	2	5	29	0	0	1	7	28	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
ROADS -											
MAINTENANCE											
3. AVOID TOE	NON-IND.PRIV	0	0	0	0	0	0	0	0	0	0
SLOPE CUTS	PLUM CREEK	0	0	0	13	0	0	0	0	13	0
	STATE LANDS	0	0	0	3	0	0	0	0	3	0
	USFS	0	0	0	16	0	0	0	0	16	0
	TOTAL	0	0	0	32	0	0	0	0	32	0
4. DRAINAGE FBP											
CLOSED ROADS	NON-IND.PRIV	0	0	0	0	0	0	0	0	0	0
	PLUM CREEK	0	0	4	4	0	0	0	5	3	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	1	7	0	0	0	1	7	0
	TOTAL	0	0	5	15	0	0	0	6	14	0
5. RESTRICTED											
WET - PERIOD	NON-IND.PRIV	0	0	1	2	0	0	0	1	2	0
USE	PLUM CREEK	0	0	2	13	0	0	0	2	13	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	17	0	0	0	1	16	0
	TOTAL	0	0	3	36	0	0	0	4	35	0
TIMBER HARVEST											
1. ADEQUATE SMZ	NON-IND.PRIV	2	0	2	0	1	1	0	2	2	0
	PLUM CREEK	0	1	3	9	6	1	0	1	17	0
	STATE LANDS	0	0	0	3	3	0	0	0	6	0
	USFS	0	3	3	16	0	0	0	6	16	0
	TOTAL	2	4	8	28	10	2	0	9	41	0
2. STREAMS FREE											
OR DEBRIS	NON-IND.PRIV	2	0	1	2	0	1	1	0	3	0
	PLUM CREEK	0	1	1	16	0	0	0	1	17	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	1	21	0	0	0	2	20	0
	TOTAL	2	1	3	45	0	1	1	3	46	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
3. AVOID EQUIP.											
IN WET AREAS	NON-IND.PRIV	0	0	1	3	0	0	0	1	3	0
	PLUM CREEK	0	0	1	14	0	0	0	0	15	0
	STATE LANDS	0	0	1	3	0	0	0	1	7	0
	USFS	0	1	2	8	0	0	1	0	10	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	1	5	28	0	0	1	2	31	0
4. MINIMIZE											
SKID DISTURB	NON-IND.PRIV	0	0	0	5	0	0	0	0	5	0
	PLUM CREEK	0	0	0	19	1	0	0	1	18	0
	STATE LANDS	0	0	0	4	2	0	0	0	6	0
	USFS	0	0	0	20	2	0	0	0	22	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	0	47	5	0	0	1	51	0
5. SKID TRAIL											
LOCATION ADED	NON-IND.PRIV	1	1	1	2	0	0	1	1	3	0
	PLUM CREEK	0	1	0	15	1	0	1	0	16	0
	STATE LANDS	0	0	0	8	0	0	0	0	6	0
	USFS	0	0	3	17	0	0	0	2	18	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	1	2	4	40	1	0	2	3	43	0
6. SKID.MINIMIZE											
SOIL COMPACT.	NON-IND.PRIV	0	0	0	4	0	0	0	0	4	0
	PLUM CREEK	0	0	0	13	1	0	0	0	19	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	0	21	0	0	0	0	21	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	0	49	1	0	0	0	50	0
7. WATER BARS											
INSTALLED ...	NON-IND.PRIV	0	0	1	1	0	0	0	1	1	0
	PLUM CREEK	0	1	2	11	0	0	2	1	11	0
	STATE LANDS	0	0	0	2	0	0	0	0	2	0
	USFS	0	0	3	12	0	0	0	1	14	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	1	6	26	0	0	2	3	29	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
TIMBER HARVEST											
8. LANDING SIZE											
AND LOCATION	NON-IND.PRIV	0	0	1	4	0	0	0	1	4	0
	PLUM CREEK	0	1	1	17	0	0	0	2	17	0
	STATE LANDS	0	0	0	6	0	0	0	1	4	0
	USFS	0	0	0	22	0	0	0	0	22	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	1	2	49	0	0	0	3	49	0
9. LOGGING											
SYSTEM	NON-IND.PRIV	0	0	0	5	0	0	0	0	5	0
	PLUM CREEK	0	0	1	17	1	0	0	1	18	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	1	21	0	0	0	0	22	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	2	49	1	0	0	1	51	0
10. WASTE											
DISPOSAL	NON-IND.PRIV	0	0	1	4	0	0	0	0	5	0
	PLUM CREEK	0	0	0	19	0	0	0	0	19	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	0	22	0	0	0	0	22	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	1	51	0	0	0	0	52	0
11. SEASON OF											
USE	NON-IND.PRIV	0	0	1	2	0	0	0	1	2	0
	PLUM CREEK	0	0	0	18	0	0	0	0	18	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	0	20	0	0	0	0	20	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	1	46	0	0	0	1	46	0
SLASH TREATMT											
SITE PREP.											
1. BRUSH BLADES											
ON DOZERS	NON-IND.PRIV	0	0	0	1	0	0	0	0	1	0
	PLUM CREEK	0	0	0	16	0	0	0	0	16	0
	STATE LANDS	0	0	0	4	0	0	0	0	4	0
	USFS	0	0	0	12	0	0	0	0	12	0
		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	TOTAL	0	0	0	33	0	0	0	0	33	0

Table 6. (continued)

		APPLICATION					EFFECTIVENESS				
BMP	OWNERSHIP	1	2	3	4	5	1	2	3	4	5
XXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
2. SCARIFICATION											
	NON-IND.PRIV	0	0	1	2	0	0	0	1	2	0
	PLUM CREEK	0	0	0	16	0	0	0	0	16	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	1	17	0	0	0	1	17	0
		XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
	TOTAL	0	0	2	41	0	0	0	2	41	0
3. OPERATION											
MINIMIZE SOIL	NON-IND.PRIV	0	0	0	3	0	0	0	0	3	0
COMPACT/DIST.	PLUM CREEK	0	0	5	10	0	0	0	3	12	0
	STATE LANDS	0	0	1	3	0	0	0	0	4	0
	USFS	0	0	1	13	1	0	0	2	13	0
		XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
	TOTAL	0	0	7	29	1	0	0	5	32	0
4. DOZERS ON											
SUITABLE	NON-IND.PRIV	0	0	0	4	0	0	0	0	4	0
SLOPES	PLUM CREEK	0	0	0	16	0	0	0	0	16	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	0	0	16	0	0	0	0	16	0
		XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
	TOTAL	0	0	0	42	0	0	0	0	42	0
5. BMP											
PROTECTION	NON-IND.PRIV	1	0	0	3	0	1	0	0	3	0
	PLUM CREEK	0	2	2	13	0	0	0	2	15	0
	STATE LANDS	0	0	0	6	0	0	0	0	6	0
	USFS	0	1	6	13	1	0	1	1	19	0
		XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
	TOTAL	1	3	8	35	1	1	1	3	43	0
TOTALS											
	NON-IND.PRIV	11	3	20	65	1	4	7	18	71	0
	PLUM CREEK	0	16	48	473	12	1	10	45	493	0
	STATE LANDS	0	0	5	164	6	0	0	6	169	0
	USFS	0	7	33	558	5	0	5	30	567	1
		XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX	XXXXXX
	GRAND TOTAL	11	26	106	1,260	24	5	22	99	1,300	1
%											
	OF TOTAL	0.3	1.8	7.4	88.3	1.7	0.3	1.5	6.9	91.1	0.1

Method 2 - Analysis of Impacts by "Percentage of Practices Audited" on Each Ownership

This approach demonstrates each individual ownership's share of the 1427 basin-wide practices audited and how each performed in controlling impacts when compared only to the practices they conducted. Figures 1 and 2 show the results of this analysis for both practice application and effectiveness, for each ownership. Further explanation on the meanings of these values is provided in the Methodologies chapter, in the section "Rating BMPs."

When short- and long-term impacts are summed and compared to "total practices audited" for each ownership, percentages of practices contributing to impacts are calculated. Figure 3 focuses specifically on this analysis and follows the tabulated numbers presented in Table 7.

Table 7. Percentage of practices with impacts.

<u>OWNERSHIP</u>	<u>PRACTICES AUDITED</u>	<u>PRACTICES W/IMPACTS</u>	<u>CONTRIBUTING TO IMPACTS</u>
Non-Indust. Private	100	29	29.0
Plum Creek Timber Co.	549	56	10.2
Dept. of State Lands	175	6	3.4
Flathead Nat. Forest	<u>603</u>	<u>35</u>	<u>5.8</u>
Totals	1427	126	8.8

Both of the preceding methodologies utilizing "total practices audited" are flawed in their use as an accurate indication of the performance and success of controlling sediment production. Within "Total Practices Audited" are a number of practices, approximately 13% of the total 1427, that are related to items which either do not directly

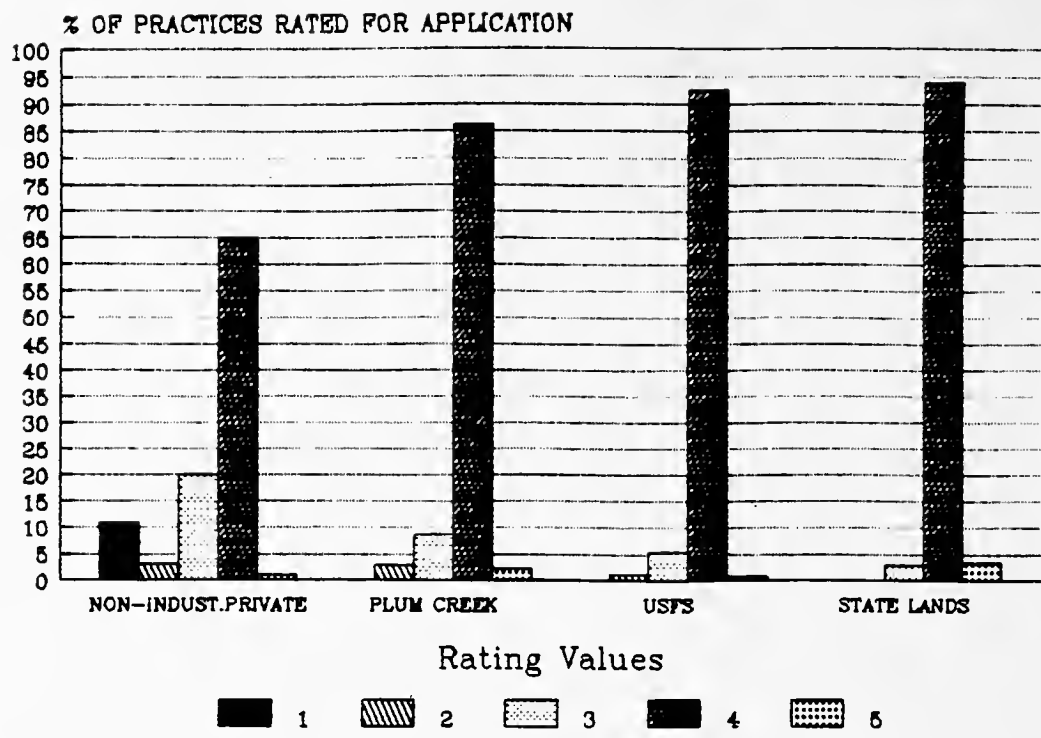


FIGURE 1

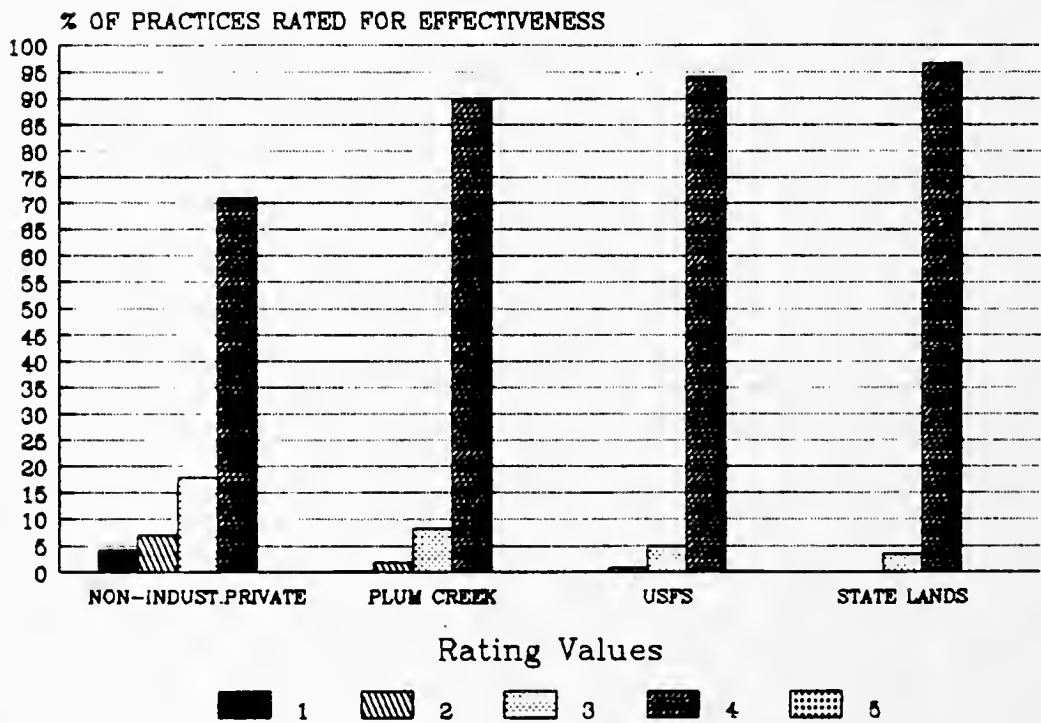


FIGURE 2

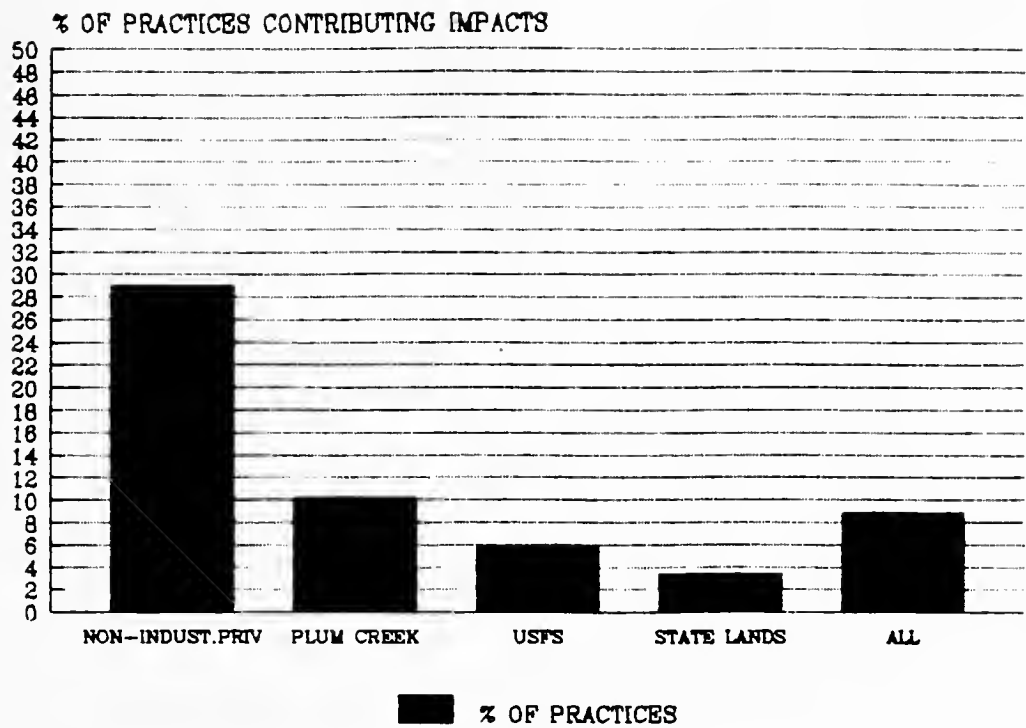


FIGURE 3

influence the production of sediment in the stream channel or are too difficult or inaccurate to attempt to assess in the post harvest time period. Those five practices are:

1. Permits obtained for stream crossings.
2. Timely installation of drainage features on roads.
3. Halting road construction during wet periods.
4. Erosion control measures are current with road construction.
5. Road use restricted during wet periods

Practices 2 through 5 have a potential to directly impact sedimentation but inspection several years following the activity does not give an accurate picture of the impacts. Adding to this potential problem is the fact that not all of the 39 practices assessed in the field carried

the same weight in potential sediment production. This point was widely recognized by audit team members.

A practice such as "waste disposal" (which scored as adequately applied and effective on all 52 sales) for which an impact could only happen if equipment oil changes occurred next to a channel, is really not as important as a practice such as "adequate SMZ maintained" which could potentially produce considerably more damage. They are, however, weighted the same when the numerical analysis is conducted.

Relying on the numbers generated using the "total practices" approach as in the two examples above, can be an inaccurate depiction of the level of protection occurring in the watershed. Practices which have a greater potential for impact should carry more weight in the final analysis.

#### Method 3 - Analysis of Ratings on a Timber Sale Basis

A different approach is to let each timber sale stand on its own merits for representing the level of practice application and protection provided to a stream. Ratings for BMP effectiveness are summarized for all minor temporary detrimental impacts (see Table 8) and for all the major impacts, both short- and long-term (see Table 9). Only the sales in which impacts were observed are listed. In the tables the BMP categories responsible for the observed impacts are noted along with the number of practices.

Figures 4 and 5 graphically summarize the data in the tables.

Table 8. Timber sales with at least one minor impact.

<u>OWNER</u>	<u>SALE NAME</u>	<u># IMPACTS</u>	<u>CATEGORY</u>
<b>NON-INDUS.</b>			
<b>PRIVATE</b>	1. BROWNS MEADOW	2	TIMBER HARVEST
	2. SALMON PRAIRIE	2	ROAD PLANNING
		1	ROAD DRAINAGE
	3. PABLO	2	ROAD DRAINAGE
		1	ROAD MAINTENANCE
		2	TIMBER HARVEST
	4. STAR MEADOWS	2	ROAD PLANNING
		1	ROAD CONSTRUCTION
		1	ROAD MAINTENANCE
		3	TIMBER HARVEST
		1	SITE PREP.

# OF SALES: 4                      18

PERCENT 80.0%            ( 4 out of 5 sales)

**PLUM CREEK**

1. SOUTH COLD	1	ROAD MAINTENANCE
2. SQUAW CAMP	2	ROAD DRAINAGE
	1	ROAD CONSTRUCTION
	3	ROAD MAINTENANCE
	2	TIMBER HARVEST
	1	SLASH TREAT/SITE PREP
3. BROOK EAST	2	ROAD DRAINAGE
	1	ROAD CONSTRUCTION
	3	ROAD MAINTENANCE
4. JIM CORNICE	2	ROAD DRAINAGE
	2	ROAD CONSTRUCTION
5. LION FLAT	1	ROAD DRAINAGE
6. G-BRANCH II	1	SLASH TREAT/SITE PREP
7. OWL ONE QTR.	1	ROAD PLANNING
	2	ROAD DRAINAGE
	1	ROAD MAINTENANCE
	3	TIMBER HARVEST
8. LOWER TAMARACK	2	ROAD DRAINAGE
	1	ROAD MAINTENANCE
9. BROWN'S MEADOW LP	1	SLASH TREAT/SITE PREP
10. DEAD ON IT'S FEET	1	ROAD MAINTENANCE
	1	SLASH TREAT/SITE PREP
11. BERNARD FLAT	1	SLASH TREAT/SITE PREP
12. AB LODGEPOLE	2	ROAD MAINTENANCE
13. WEST JIM	1	ROAD DRAINAGE
	2	ROAD CONSTRUCTION
	1	ROAD MAINTENANCE

Table 8 (continued)

		3	TIMBER HARVEST	#
OF SALES:	13	45		
PERCENT	<u>68.4%</u>		(13 out of 19 sales)	
USFS	1. NINKO MILLER	3	ROAD DRAINAGE	
		1	ROAD CONSTRUCTION	
		2	ROAD MAINTENANCE	
	2. LOGAN FALLS	1	ROAD PLANNING	
	3. BILL CREEK	1	TIMBER HARVEST	
	4. DUNN TEPEE	1	TIMBER HARVEST	
	5. COAL RIDGE	1	ROAD PLANNING	
		1	ROAD DRAINAGE	
		2	ROAD CONSTRUCTION	
		4	TIMBER HARVEST	
		2	SLASH TREAT/SITE PREP	
	6. NAPA GOAT	1	ROAD PLANNING	
		1	ROAD MAINTENANCE	
		1	TIMBER HARVEST	
	7. MIDDLE FORK LP	1	ROAD DRAINAGE	
		1	TIMBER HARVEST	
	8. TERRACE HILL	1	ROAD MAINTENANCE	
	9. SANDERS HAND	2	SLASH TREAT/SITE PREP	
	10. MISSION BUTTE	2	TIMBER HARVEST	
	11. ELK COLD	1	TIMBER HARVEST	
		30		
# OF SALES:	11			
PERCENT	<u>50.0%</u>		(11 out of 22 sales)	
STATE LANDS				
	1. LOWER CILLY	1	TIMBER HARVEST	
	2. SOUTH COAL CREEK	1	ROAD PLANNING	
		1	ROAD DRAINAGE	
		1	ROAD CONSTRUCTION	
		1	ROAD MAINTENANCE	
	3. SWAN RIVER	1	ROAD DRAINAGE	
		6		
# OF SALES:	3			
PERCENT	<u>50.0%</u>		(3 out of 6 sales)	
ALL OWNERSHIPS				
PERCENT	<u>59.6%</u>		(31 out of 52 sales)	

Table 9. Timber sales with at least one major impact

# OF CONTRIBUTING PRACTICES RELATED TO EACH SALE:				
SHORT TERM IMPACTS			LONG TERM IMPACTS	
OWNER / SALE NAME	QTY	CATEGORY	QTY	CATEGORY
NON-IND. PRIVATE				
1. BROWNS MEADOW	1	TIMBER HARVEST	-	-
2. STAR MEADOWS	1	ROAD PLANNING	-	-
	2	ROAD DRAINAGE	-	-
	2	ROAD CONSTRUCT	-	-
	1	TIMBER HARV.	2	TIMBER HARV.
	1	ROAD MAINTEN.	-	-
			1	SLASH/SITE P.
# OF SALES: 2	8		3	
PERCENT 40 %	( 2 out of 5 sales)			
PLUM CREEK				
1. SQUAW CAMP	1	ROAD PLANNING	-	-
	1	ROAD DRAINAGE	-	-
	2	TIMBER HARV.	1	TIMBER HARV.
2. JIM CORNICE	1	TIMBER HARV.	-	-
3. WEST JIM	2	ROAD PLANNING	-	-
	1	ROAD DRAINAGE	-	-
	1	RD. CONSTRUCT	-	-
	1	ROAD MAINT.	-	-
# OF SALES: 3	10		1	
PERCENT 15.8%	( 3 out of 19 sales)			
USFS				
1. LOGAN FALLS	1	ROAD MAINT.	-	-
2. BILL CREEK	1	TIMBER HARV.	-	-
	1	SLASH/SITE P.	-	-
3. NAPA GOAT	2	ROAD DRAINAGE	-	-
SALES: 3	5		0	# OF
PERCENT 13.6%	(3 out of 22 sales)			
DEPT OF STATE LANDS				
# OF SALES: 0				
PERCENT 0.0%	(0 out of 6 sales)			
ALL OWNERSHIPS				
PERCENT 15.4%	(8 out of 52 sales)			

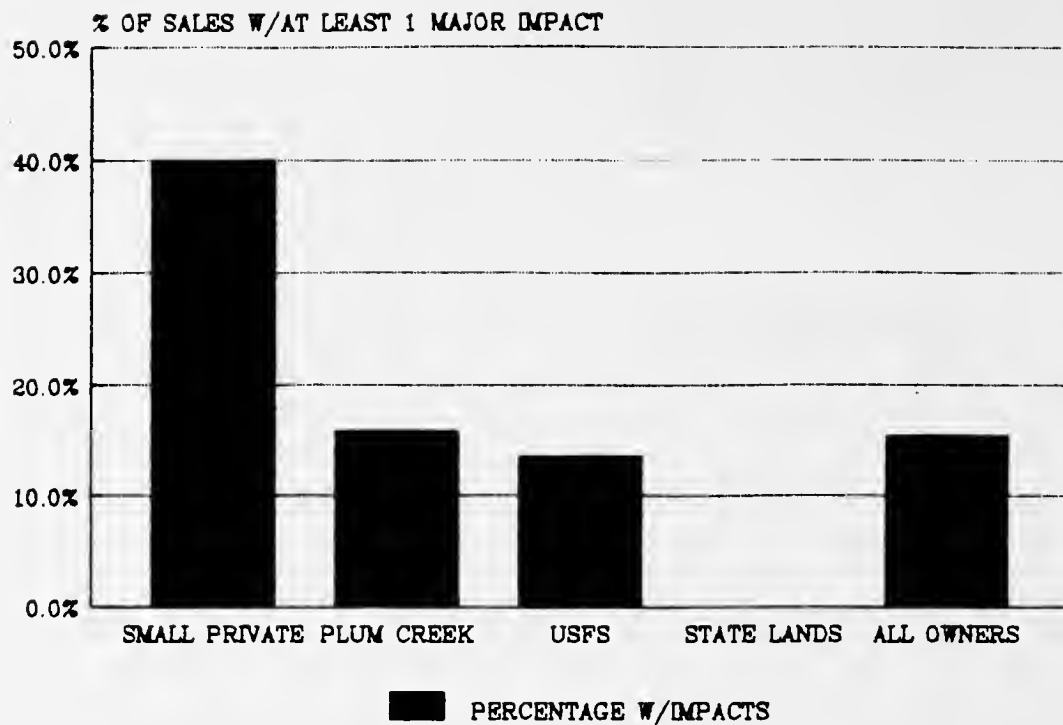


FIGURE 4

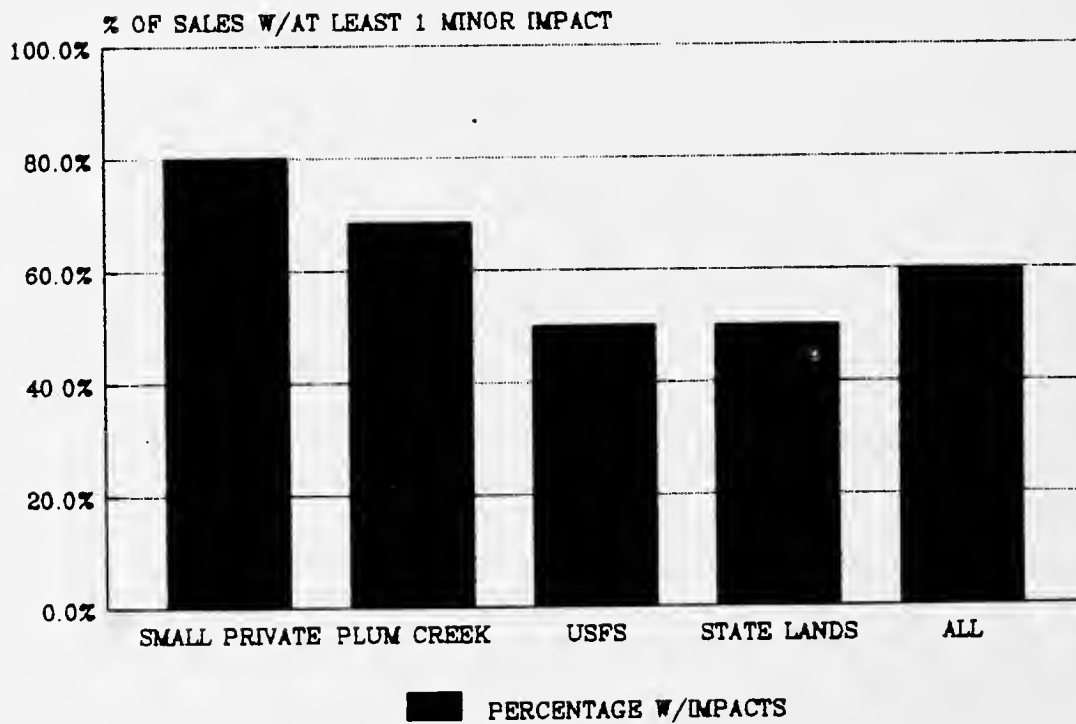


FIGURE 5

## COMPARISON OF PERFORMANCE BETWEEN THE FLATHEAD BASIN AND THE STATE OF MONTANA

The Montana Environmental Quality Council (EQC) utilized the following approaches in analyzing the results of the 1988 statewide BMP assessment:

1. % of Total Practices in Each Rating Category
2. Number of Sales with Various Levels of Departure and Impacts
  - a. # with at least 1 major practice departure
  - b. # with at least 1 practice rating as a major impact

3. Number of Significant Problems Per Timber Sale

Each of these methods will be examined and comparisons made in to order to establish whether there are differences in the results of the two assessments.

Table 10 shows a comparison between the "% of Total Practices in Each Rating Category." The grouping of data from 5 classes to 3 classes was done to accommodate the use of a statistical method to test the probability of no significant difference between the results of these studies. Graphical comparisons, found in Figures 6 and 7, show how the 3 classes compare between the Flathead Basin and EQC audits.

The Chi-Squared ( $\chi^2$ ) Test was conducted, and is well suited for testing hypotheses about independent samples of ordinal data. The calculations are illustrated in Table 11.

The result of this analysis is that we cannot reject the hypothesis that there is "no significant difference" between the results of these two studies.  $\chi^2$  values as large as we observed indicates that the differences are probably significant and not due to chance.

Table 10. Comparison of the 1989 Flathead Basin BMP assessments with the 1988 statewide BMP assessments.

<u>APPLICATION OF BMPS</u>				
<u>BMP STUDY</u>	<u>MAJOR DEPARTURES</u> <u>(rating 1-2)</u>	<u>MINOR DEPARTURES</u> <u>(rating 3)</u>	<u>ADEQUATE OR EXCEEDS BMPs</u> <u>(rating 4-5)</u>	<u>TOTAL</u>
EQC STATEWIDE (38) <sup>1</sup>				
# OF PRACTICES	45	126	754	925
% OF PRACTICES	5%	14%	81%	100%
FLATHEAD BASIN (52) <sup>1</sup>				
# OF PRACTICES	37	106	1286	1429
% OF PRACTICES	3%	7%	90%	100%
<u>EFFECTIVENESS OF BMPS</u>				
<u>BMP STUDY</u>	<u>MAJOR IMPACTS</u> <u>(rating 1-2)</u>	<u>MINOR IMPACTS</u> <u>(rating 3)</u>	<u>ADEQUATE OR BETTER</u> <u>(rating 4-5)</u>	<u>TOTAL</u>
EQC STATEWIDE:				
# OF PRACTICES	31	117	777	925
% OF PRACTICES	4%	13%	83%	100%
FLATHEAD BASIN:				
# OF PRACTICES	27	99	1303	1429
% OF PRACTICES	2%	7%	91%	100%

1 - Represents the number of sites audited in each study.

# COMPARISON OF BMP APPLICATION

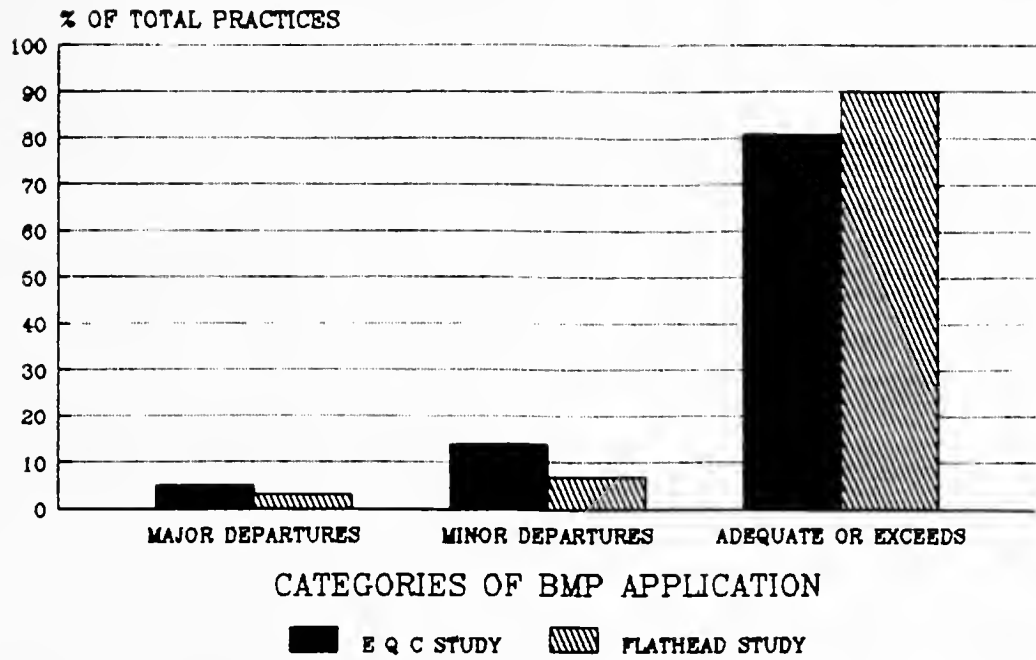


FIGURE 6

# COMPARISON OF BMP EFFECTIVENESS

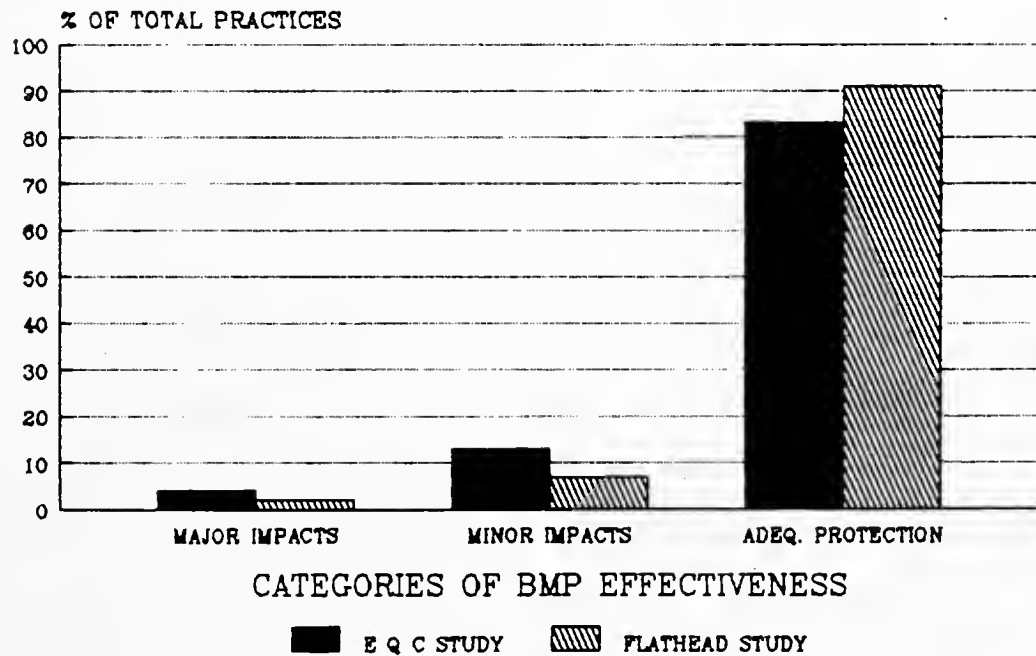


FIGURE 7

Table 11. The  $\chi^2$  Test For Significant Difference Between the EQC and Flathead Basin BMP Assessment Results

**HYPOTHESIS:** THERE IS NO SIGNIFICANT DIFFERENCE BETWEEN THESE RESULTS.

**EQUATION:** 
$$\chi^2 = \frac{\text{SUM ALL (OBSERVATIONS - EXPECTED VALUE)}^2}{\text{EXPECTED VALUE}}$$

OBSERVATIONS = FLATHEAD BASIN RESULTS

EXPECTED VALUES =  $P \times n$

EQC'S PROPORTION OF OBSERVED RATINGS (P), FOR EACH OF 3 CLASSES, MULTIPLIED BY THE SAMPLE SIZE (n).

$n = 1427$ , SAMPLE SIZE OF PRACTICES IN THE FLATHEAD STUDY  
d.f. = 2

BMP APPLICATION: PRACTICES	RATING CLASSES			TOTAL
	MAJOR DEPARTURE (rating 1-2)	MINOR DEPARTURE (rating 3)	ADEQUATE OR EXCEEDS BMP (rating 4-5)	
OBSERVED (O)	37	106	1284	1427
EXPECTED (E) = $P \times n$	$.05 \times 1427$ = 71	$.14 \times 1427$ = 200	$.81 \times 1427$ = 1156	

CHI - SQUARE CALCULATING TABLE :

O - E = D	34	94	128	
D <sup>2</sup>	1156	8836	16,384	
$\chi^2 = \text{SUM ALL } D^2/E:$	16.28	44.18	14.17	= 74.63

USING OUR  $\chi^2$  VALUE OF 74.63, AND REFERRING TO A TABLE OF  $\chi^2$  PROBABILITY VALUES USING 2 "DEGREES OF FREEDOM" YIELDS:

**THE PROBABILITY OF "NO SIGNIFICANT DIFFERENCE" < 0.1 %**

THIS INDICATES THE DIFFERENCES OBSERVED IN THE APPLICATION OF BMPs BETWEEN THE TWO STUDIES IS ALMOST CERTAINLY SIGNIFICANT AND NOT DUE TO CHANCE.

Table 11 (continued)

BMP EFFECTIVENESS:		RATING CLASSES		
		MAJOR IMPACTS	MINOR IMPACTS	ADEQUATE OR BETTER
PRACTICES		(rating 1-2)	(rating 3)	(rating 4-5)
OBSERVED (O)		27	99	1300
EXPECTED (E)		.035 x 1427 = 50	.13 x 1427 = 186	.835 x 1427 = 1192
		TOTAL		
		1427		

CHI-SQUARED CALCULATING TABLE:

O - E = D	23	87	108	
D <sup>2</sup>	529	7569	11664	
X <sup>2</sup> = SUM ALL D <sup>2</sup> /E:	10.58	+ 40.69	+ 9.78	= 61.06

USING THE X<sup>2</sup> VALUE OF 61.06, WITH 2 DEGREES OF FREEDOM, IN THE X<sup>2</sup> TABLE YIELDS:

**A PROBABILITY OF "NO SIGNIFICANT DIFFERENCE" < 0.1 %**

THIS INDICATES THE DIFFERENCES OBSERVED IN THE EFFECTIVENESS OF BMPs IN MITIGATING RESOURCE IMPACTS, BETWEEN THE TWO STUDIES, IS ALMOST CERTAINLY SIGNIFICANT AND NOT DUE TO CHANCE.

Another approach to comparing the results of these two studies looks at the percentage of timber sales displaying departures from BMPs and impacts. For each study, a combined percentage of timber sales with "at least one major practice departure" for application and "at least one major impact" for effectiveness is calculated. The Flathead Basin results for the two values were 19.2 % and 15.4 %, respectively. The statewide results were 52.6 % and 42.1%, respectively. These values are shown in Figure 8.

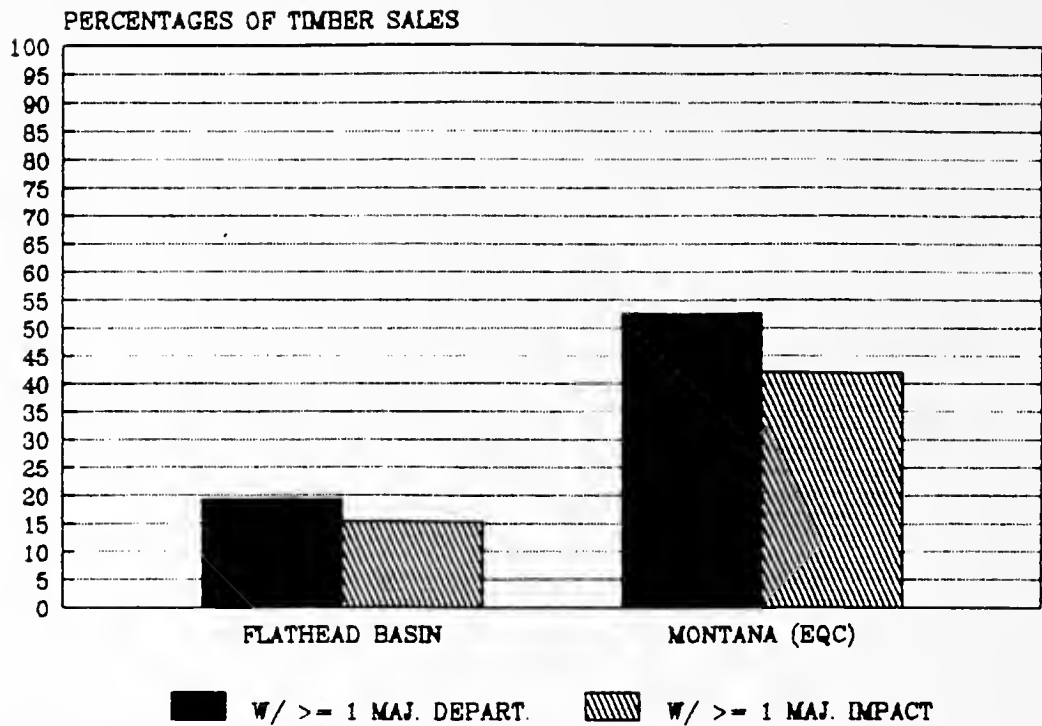


FIGURE 8

A third comparison looks at the number of actual impacts per sale as an indicator of "significant problems per sale." This is achieved by summing the short- and long-term major impacts recorded for each study and dividing by the number of sales audited. The same calculation is then done for the minor impacts. The results for the Flathead Basin study are .52 for major impacts and 1.9 for minor impacts compared to .82 and 3.1, respectively, for the State. Figure 9 shows these comparisons.

This analysis indicates that in the Flathead Basin, nearly 1 major impact is occurring for every 2 timber sales conducted. Similarly, almost 2 minor impacts are occurring on every timber sale harvested.

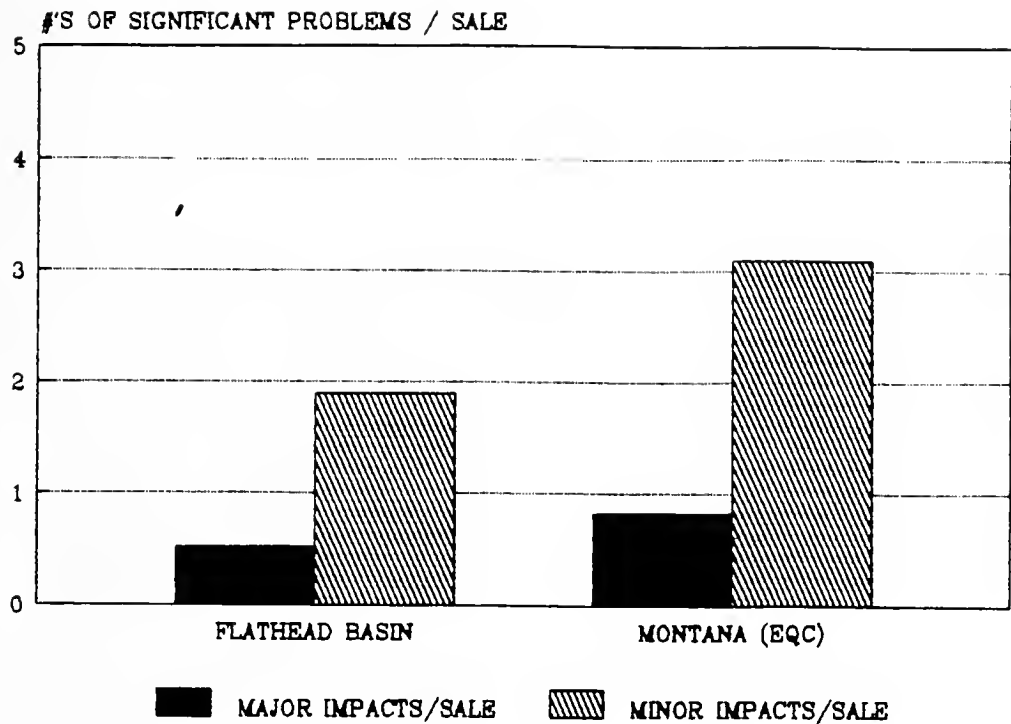


FIGURE 9

#### ANALYSIS OF IMPACTS BY BMP CATEGORIES

This analysis is intended to demonstrate categories of BMP implementation that are in need of improvement. Table 12 summarizes major and minor impacts by respective BMP categories.

The Timber Harvest and Road Drainage categories had the greatest number of impacts with Road Maintenance following closely behind. Figure 10 shows how each ownership performed in each BMP category when minor and major impacts were summed and taken as a percentage of the total impacts.

#### Streamside Management Zones

Adequate Maintenance of the Streamside Management Zone (SMZ) had the greatest number of departures and impacts. Twenty-seven departures out of the total of 143 (19%) were

Table 12. Summary of BMP categories contributing to soil and water impacts.

**MINOR IMPACTS: # OF PRACTICES CONTRIBUTING TO IMPACTS**

<u>BMP CATEGORY</u>	<u>NON-IND. PRIVATE</u>			<u>PLUM CREEK</u>			<u>USFS</u>			<u>STATE LANDS</u>			<u>TOTAL PCT.</u>	
	<u>QTY</u>	<u>%</u>	<u>*</u>	<u>QTY</u>	<u>%</u>	<u>*</u>	<u>QTY</u>	<u>%</u>	<u>*</u>	<u>QTY</u>	<u>%</u>	<u>*</u>	<u>%</u>	<u>*</u>
ROAD PLANNING	4	22	*	1	2	*	1	3	*	1	17	*	7	
ROAD DRAINAGE	3	17	*	12	27	*	7	23	*	2	33	*	24	
ROAD CONSTRUCT.	1	5	*	6	13	*	3	10	*	1	17	*	11	
ROAD MAINTEN.	2	11	*	14	31	*	4	13	*	1	17	*	21	
TIMBER HARVEST	7	39	*	7	16	*	11	37	*	1	17	*	26	
SLASH TREATMENT	1	5	*	5	11	*	4	13	*	0	17	*	10	
TOTAL	18	100		45	100		30	100		6	100		100	

**MAJOR IMPACTS: # OF PRACTICES CONTRIBUTING TO IMPACTS**

<u>BMP CATEGORY</u>	<u>NON-IND. PRIVATE</u>	<u>PLUM CREEK</u>	<u>USFS</u>	<u>STATE LANDS</u>	<u>TOTAL</u>	<u>PCT.</u>
ROAD PLANNING	1	3	0	0	4	15
ROAD DRAINAGE	2	2	2	0	6	22
ROAD CONSTRUCTION	2	1	0	0	3	11
ROAD MAINTENANCE	1	1	1	0	3	11
TIMBER HARVEST	4	4	1	0	9	33
SLASH TREATMENT	1	0	1	0	2	7
TOTAL	11	11	5	0	29	100%

COMBINED TOTAL

MINOR & MAJOR	29	56	35	6	126
---------------	----	----	----	---	-----

TOTAL #'S OF PRACTICES

100	549	603	175	1427
-----	-----	-----	-----	------

PCT. OF TOTAL

29%	10%	6%	3%	9%
-----	-----	----	----	----

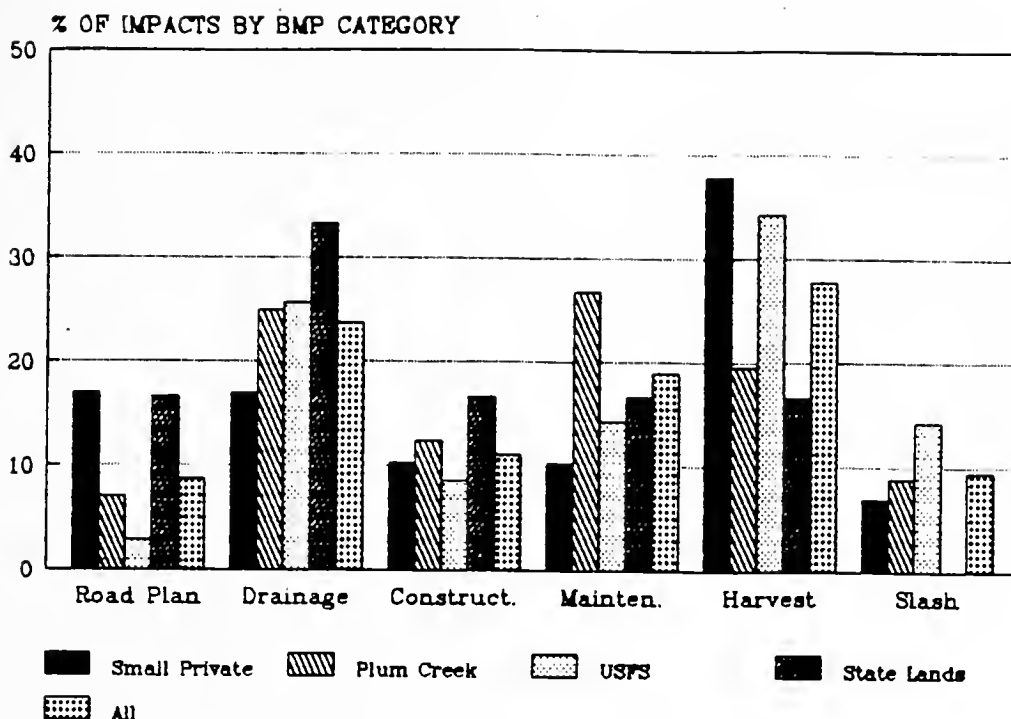


FIGURE 10

attributable to the practice of SMZ protection, both during the harvest and during slash reduction.

Rating the practice involved assessing the effectiveness of the vegetative buffer zone along a riparian area and its capacity to act as a filter for sediment, a zone of stabilization for the channel, and to provide shade and woody debris recruitment for fisheries habitat. Departures in this practice could include damage to the stream bank or bed due to operation of equipment across the stream channel during skidding or slash piling, insufficient stand of timber or vegetative cover left to provide shading and temperature control and excessive soil disturbance on the flood plain and adjacent to the channel. Teams did not

rate this area as a "zone of exclusion" from the harvesting of timber, but instead rated it on it's ability to function effectively.

Teams did not want to see equipment operating in such a way that it breached the natural topographic break of an incised channel. Teams also scored practices lower if excessive soil disturbance was observed at the immediate edge of such a slope break. Operation of equipment on these slopes not only increases the risk that displaced soil will move under the forces of gravity into the riparian area or flood plain, it also sets up a network of ruts from the treads or tracks. These provide increased efficiency for transport of water and sediment downslope, increasing potential impacts to streams. Instead of measuring out some distance from the middle of the stream channel to establish an SMZ, it was generally felt that simply staying up on these benches above natural slope breaks would significantly reduce the potential for channel impacts.

On deeply incised channels, where there is considerable distance between the activity on the slope and the channel, equipment operation below the natural topographic slope break was considered appropriate. However, there should be sufficient surface roughness with ground cover and woody debris in the designated SMZ to detain any soil which may be detached upslope, and dissipate any energy associated with surface runoff. If an adequate buffer can be established,

then the limiting factors in these instances becomes soil retention on the slope for productivity and the safe operation of equipment.

Wet sites displaying numerous stream channels or shallow water tables were recognized as difficult situations for maintaining an adequate SMZ. Any stand of timber left to provide an effective SMZ was recognized as susceptible to "blowdown." In other instances, excessive soil disturbance by equipment can break through the surface soil layer and expose a new channel for conveyance of water on-site. Operating on frozen soils is recognized as one method of addressing the latter problem.

The EQC's BMP Technical Committee produced a definition for an SMZ that included a minimum width of 25 feet as a management objective. Since the teams would be rating the adequacy of the streamside management zone in protecting soil and water resources for 52 timber sales, we had the opportunity to answer 2 additional questions regarding the width of these zones. Those findings are summarized below, and provide some insight into where we have been with respect to the application of a buffer zone.

These data are not intended to assess compliance with the recent "25 foot" definition which has not been in existence long enough to provide ample implementation time. Instead, we gathered these data to record the state of practice prior to the recent definition.

1. Was a 25 foot, minimum width, SMZ maintained ?	#'s of Sales		
	YES	NO	TOTAL
NON-INDUS PRIV.	1	4	5
PLUM CREEK	14	5	19
STATE LANDS	6	0	6
USFS	17	5	22
<hr/>			
TOTAL	38	14	52
PERCENT	73.1%	26.9%	100.0%
# of sales displaying impacts associated with application of the 25 foot SMZ criteria:	3	8	11
	27%	73%	100%

On 8 of the 11 timber sales (73%), the SMZ width was less than 25 feet and impacts directly related to this criteria were observed. On 3 sales, impacts were noted even though a 25' buffer had been provided. In one case the thin stand of trees left as an SMZ was damaged by wind, leaving behind an inadequate filter strip. In 2 other instances the 25' slope distance was inadequate (given the incised channel and steep (80%+) slope) to trap the detached soil. This seems to support the position that a 25 foot minimum width SMZ may be inadequate to provide sufficient protection of the water resources in many instances.

It was noted that leaving a 25' wide stand of trees may, in fact, increase the risk of blowdown on some sites. Removal of the stand in a well-planned and executed treatment could prevent the introduction of large amounts of sediment into the channel at a later date. In some areas, the removal of an adjacent timber stand clearly "sets up"

the riparian areas for a potential blowdown event, and damage to the channel. More work is needed to explore treatment options designed specifically to minimize the potential of increased sedimentation from these events.

On 6 sales the SMZ was less than 25' and yet no impacts were documented. In these cases equipment operation in the channel during yarding, slash piling in the channel and excessive soil disturbance were noted. These were in poorly defined ephemeral and intermittent channels. While the teams found the practices associated with the SMZ to be a departure from preferred practices, it was difficult to determine if sediment resulting from the disturbance had moved down the channel and/or off-site. The fact that impacts hadn't been recognized was viewed possibly as a result of recent historically low precipitation and the timing of runoff events, or combination of events. However, the lack of impacts was not viewed as an appropriate justification for relaxing the SMZ requirement in these headwater drainages, as problems were viewed on other similar sites where the combination of events resulted in dramatically different results.

Using landtype maps and the professional judgement of the team members, each site was characterized for erosion potential. Of the 11 timber sales on which impacts related to SMZ maintenance were noted, 3 (27%) were on "low" risk sites while 8 (73%) were on "moderate" risk sites.

2. Is 25 feet an adequate distance for an SMZ, given the site's physical characteristics and harvest prescription ?

	#'s of Sales		
	YES	NO	TOTAL
NON-INDUS PRIV.	4	1	5
PLUM CREEK	13	6	19
STATE LANDS <sup>1</sup>	2	2	4
USFS	15	7	22
TOTAL	34	16	50
PERCENT	68.0%	32.0%	100.0%

1) Two of the State Lands sales did not have complete data.

The following reasons were recorded explaining why a 25 foot SMZ width was deemed inadequate on 32% of the timber sales.

1. Deeply incised channels with 40% + adjacent slopes leading down to stream banks provided too efficient delivery of sediment to the stream, with inadequate filtering capability.

2. A 25 foot distance would leave the edge of the buffer below a natural topographic break between upland and riparian areas. Any operation of equipment below the natural break was viewed as too great a risk for excessive soil and/or channel disturbance. A 25 ' buffer was only acceptable if cable yarding had been exercised.

3. Either a high water table, as characterized by the prevalence of wet or moist vegetation types, or a meandering stream channel were situations where the teams preferred to see wider buffer strips left intact.

4. Evidence of an areas susceptibility to blowdown.
5. High fishery values associated with some streams.
6. Fine textured soils, lacking in cohesion with an absence of coarse fragments.

### CONCLUSIONS

At the present time there is no proven link between the qualitative results obtained from BMP audits and quantitative impacts which may result in stream channels. Accelerated sediment production is still recognized as the primary forest management-related water quality problem in the western United States. When BMPs are implemented the effect of forest practices on sediment production is low (Stednick, 1987). Determining an acceptable level or measurement criteria for BMP performance for controlling sediment production, is necessary for assessing results and determining if adequate protection is being provided. Montana has not established what this level is.

It should be remembered that BMPs are designed only to deal with sediment production from surface erosion. In-channel erosion may be as important and is associated with increases in water yield resulting from removal of vegetation.

This section will examine the results and discuss areas in BMP implementation where improvements are needed. Again, "impacts" are defined only within the context of this qualitative assessment process.

### Performance in the Flathead Basin

Using one of the 1988 Montana EQC's analysis techniques, examining the percentages of total practices in each of the 5 rating categories (see Table 6) reveals very high levels of BMP application and effectiveness in the Flathead Basin. Several methods of analysis (see also Figures 6 - 9) indicate those levels are substantially higher than the levels observed in the 1988 statewide audits by the EQC. However, the numbers are not quite so encouraging considering that 31 of 52 (59.6%) of the timber sales audited in the Flathead were found to be contributing at least one minor or major impact to water quality. Figures 4 and 5 break these findings down by ownership and between major and minor impacts.

Minor impacts and their accompanying sediment production should not be underestimated. If land managers are to control the cumulative effects of their practices then they should strive to improve upon performance in this category, as well.

Furthermore, another analysis of the audit data indicates that almost 1 major impact to water quality is occurring for every 2 timber sales harvested (Figure 9). With the exception of the non-industrial private group, land owners in the Flathead Basin performed better than their counterparts statewide.

One might ask whether the approximate 90 % level of "application" and "effectiveness", using the "% of total practices audited" analysis technique, means that adequate protection of water quality has been provided. Such interpretations rely on the assumption that adequately applied and effective practices will minimize non-point source pollution.

It was found that only one practice departure on a sale could produce significant sediment. For example, consider a stream channel that has been severely damaged through a reach as a result of equipment operation in and around it. There is only one practice out of 39 on the audit form that specifically addresses this problem. If that practice scored the lowest it possibly could on the scale, and no other practices were found to be contributing impacts, then the lowest that timber sale would score would be a 97.4% as the level of protection afforded to water quality.

This implies that impacts on soil and water resources can be occurring on a timber sale even though the percentage of practices that were adequately applied and effective is reported as high as 97%. In that context, a score in the 90 percent range, could, in fact, have many serious impacts.

Caution should be exercised in relying solely upon interpretation of the "% of Total Practices Audited" as a measure of protection of the soil and water resources. It may be useful in determining the level of practice

application, but without conducting other analyses and examining the specific practices that represent the departures, its usefulness for assessing the level of watershed protection is limited. This position is based on the considerable variation in the "relative importance" of the 39 practices audited and their influence in protecting water quality. Therefore, they should not be weighted equally in the final analysis. Assigning "weights" to practices, weighting those with the most direct influence on sediment production higher than others, and recalculating a weighted percentage of practices contributing impacts would potentially be a more meaningful assessment of performance.

Targeted levels for either the percentage of timber sales contributing impacts, or the proportion of practices per sale, should be established as a goal. It is difficult to establish a level of adequacy because no research has been conducted to date. Clearly more can be done, not only to establish a more accurate means of analyzing practice performance, but more can be done on-the-ground and in the planning of sales, to achieve the ultimate goal of reducing the number of impacts resulting from land management activities.

A conservative goal might be a 30% reduction in each category of timber sales contributing impacts. This would amount to lowering the current level of sales contributing

major impacts from 15 % to around 10 %. On sales with minor impacts, this would amount to a drop from 60 % to about 40 % of sales producing minor impacts.

#### Areas For BMP Improvements

Areas where specific BMPs were found lacking included headwater drainages, sensitive site types, riparian areas with inadequate width SMZs and with poorly defined boundaries, and in roads drainage and maintenance schedules. Improvements are clearly needed in education, sale planning and administration, recognition of sensitive site conditions needing protection, improved management of streamside vegetative buffer strips (SMZs), and improved construction and maintenance of road drainage features to insure that water is not allowed to build up on the road surfaces or flow directly into a stream without passing through a vegetative filter.

##### **1. BMP Education**

Education in BMP application and effectiveness is one of the first steps toward protecting water quality. Various programs have existed, on a limited basis, in the Flathead Basin to improve BMP education. Efforts include education sessions conducted by the Montana Logging Association. Other organized efforts include the Plum Creek's distribution of the State's educational BMP handbook to loggers and equipment operators. These efforts are important in reaching those operators whose actions are

often times the most critical in providing protection to soil and water resources.

While it is widely recognized that equipment operators can create damage, it was observed that many planners and agency personnel were lacking a general familiarity with the terminology and practices contained in the State's BMPs.

The U.S. Forest Service's Region 1 "Soil and Water Conservation Practices Handbook" (U.S.D.A. Forest Service 1988) contains many of the same practices, but specific subjects such as the management of an streamside management zone (SMZ) are not covered. Practices are identified for protection of the stream channel under the sections addressing timber harvesting and transportation planning but specific mention of maintaining any intact vegetative buffer zone is absent.

A basin-wide organized education program aimed at promoting BMPs, similar to the Montana Logging Associations efforts, involving loggers, equipment operators, resource planners, and administrators, from agencies and industry, would be of value. This program should include information on identifying areas in need of protection or special treatments.

## **2. Sale Planning and Administration**

Adequate implementation of BMPs is not solely a problem for equipment operators and timber sale administrators. Frequently their actions have been cited as those most

directly responsible for problems on the ground. In some instances, it is important to focus attention on the planners and their responsibility for road and sale layout that often guides the administrator's hand.

On some Forest Service sales the administrator felt he was restricted by sale layout and road design in the practices that he could carry out. He felt as if he had been "dealt a bad hand" and was in the position of making the best of the situation. The sale layout and associated road construction may play a large part in the skidding and yarding decisions on the ground. Some latitude to make changes in sale layout, during sale administration, was observed to recognize needs for resource protection. Education of the sale planners and active participation between administrator and planners would contribute toward reducing these problems.

The work of sale administrators was generally very conscientious but varied among individuals. No one ownership performed any better than another in sale administration. Departures in BMPs could generally be attributed to either an operator not paying attention to the instructions of the administrator or the administrator's judgement of the erosional response of a piece of ground to the prescribed treatment. Any departures seemed to be attributable to the frequency that an administrator could

visit a site to supervise and the administrator's experience in working on similar site conditions.

The involvement of soil and water specialists in situations which are unfamiliar to an administrator is necessary to provide inputs on the risks to soil and water resources associated with the selection of a harvesting system.

The following suggestions may improve the administrator's success in BMP implementation:

1. Increase communication with sale planners concerning sale layout.
2. Involve soil and water specialists in evaluation of erosion potential and BMP selection.
3. Employ more aggressive flagging of streamside management zones (SMZ).
4. Increase the frequency of on-site practice inspection, particularly when operations are occurring in or adjacent to sensitive areas.
5. Conduct post-sale review of practices and their effectiveness. This might provide the opportunity to correct any departures prior to an impact occurring while equipment is still available on-site or in an adjacent cutting unit.
6. Develop the ability to interpret the need for BMPs and their correct application under varying site conditions.

### 3. Recognition of Site Conditions in Need of Protection

On sites immediately adjacent to perennial streams, practices were generally adequate or better in application and effectiveness. Along those streams that had easily recognized beneficial uses, such as a spawning gravels for fish, the planning and implementation of practices was very good and water quality was adequately protected. These sales typically had the SMZ clearly flagged or otherwise marked. Topography and vegetation were used to establish boundaries for equipment operations.

Problems were observed more frequently in headwaters areas where the intermittent and ephemeral channels were weakly defined and not recognized as requiring protection. The use of existing roads next to those channels, skidding of logs across the channels, equipment operation damaging riparian vegetation, and ruts from equipment operation were observed on a number of sales.

Teams recognized that water yield increases resulting from harvest, could aggravate erosion in these channels that frequently do not flow water. Considerable erosion and off-site delivery of sediment was observed which points out the need for recognizing the potential impact of increased flows in stream channels. This should be considered this during practice selection.

Low-gradient roads, constructed in fine-textured, low-cohesion soils showed a considerable amount of erosion

under circumstances that would not generally be expected. Team members were surprised at the extent of erosion taking place. These roads were low-standard, without drain features, typically 3 - 4% slope, running laterally across the base of the sale area and below a rather large contributing area for capturing and releasing water. Discussions centered on the impacts of increased water yield resulting from the harvest or raised water table as a possible contributing factor to increased erosion on these sites.

Other considerations include available water on-site. Wet sites, which either have relatively shallow ground water tables, poor soil drainage characteristics, higher precipitation, or a combination of all 3, were a source of problems observed in practice application and associated impacts.

Sales audited in the Swan River drainage included a proportionately higher number of wet sites, primarily associated with Plum Creek Timber's ownerships. Even though attempts had been made to delineate SMZs, avoid equipment operation in those areas, and operate with seasonal restrictions such as winter harvesting, impacts were far more frequent on these sites than on drier sites. On wet sites it becomes even more important to adjust practices to protect the integrity of the SMZ and improve the frequency and standards of road surface drainage.

On sensitive sites, whether due to soil erodibility, slope, or excess water, the following practices should be given added attention:

1. Maintaining an adequate-width vegetation buffer strip (SMZ) between any management activity and the stream channel. Activities presenting potential soil disturbances include construction and maintenance of roads and equipment operation associated with harvesting and slash treatment.
2. Improved routing of water from road surfaces or skid trails through an adequate SMZ to slow the flow of water and dissipated it's erosive energy and trap any sediment being transported.
3. Improved frequency of road maintenance inspections, paying particular attention to berms that are retaining water, plugged ditches and culverts or surface washing caused by a buildup of water

While each of these practices are important on all sites, they become particularly critical on sensitive sites. If these three practices are implemented with increased frequency, and are effective, then the vast majority of potential impacts to water quality will be avoided.

It becomes more important, and at the same time more difficult, to delineate an adequate SMZ width on wet site types. The ground can be completely saturated beneath thick

organic layers and the water table position will vary considerably with topography.

Problems were observed in cases where large tracts of land received the same management practices. On two different sales, teams felt that the impacts that were observed were simply due to the size of the harvest areas. The areas were too large for the administrator to adequately control the practices given the variation in site characteristics. A suggestion was made to possibly break up the larger unit into smaller units with different treatment zones. Practices should be altered for micro-site characteristics such as wet areas, or soils texture changes to reduce the potential for impacts.

On smaller parcels of land, frequently there are fewer miles of road to contend with, and less potential for related erosion problems. The Department of State Lands had small timber sale areas and frequently timber could be reached without additional road construction. This limited the opportunities to assess new road construction on their lands, but resulted in fewer impacts from their sites.

#### **4. Streamside Management Zones**

The SMZ is often mistakenly thought of as a zone of "exclusion." Timber may be harvested there, but additional care must be exercised in these "HIGH HAZARD" areas. The 1990 Montana BMP Work Group has agreed to label any harvesting activity in an SMZ as a potential "HIGH HAZARD"

(Montana's BMP Work Group, 1990). Operations in these areas may significantly increase the risk of damage to channels and increased delivery of sediment. Any harvest activity should include special considerations to minimize soil disturbances, and maintain a zone of vegetation which functions to provide adequate channel stabilization, shade, sediment filtering capability and woody debris recruitment.

In cases where efforts had been made to physically mark an SMZ, the practices were considerably improved over those without such marking. On a number of sites, encroachment of equipment into stream channels or excessive disturbance in the SMZ was observed. This was the practice with the highest number of departures. Improvements are needed in the recognition and identification of this vegetative buffer for improved protection.

In conjunction with this study, techniques to establish an improved method for delineation of the SMZ based on vegetation characteristics and slope of adjacent land were examined. To date, the only accepted distance criteria for SMZ width is the 25 foot minimum width established by the Environmental Quality Council (EQC, 1989). The Flathead Basin audit teams were in general agreement that the natural topographic slope break should be adhered to as the boundary for the SMZ on sites with deeply incised channels. The only exception to this occurs on sites where the slope distance from the channel to the slope break is a considerable enough

distance to allow the establishment of an adequate buffer zone on the lower portion of the slope.

In some cases, adequate protection of the SMZ had been provided during the timber harvest operation, only to be damaged during the slash reduction and site preparation. This points out the need for protection through all phases of the operation.

Often the timber that was left in an adequate SMZ had been lost to blowdown. Shallow rooting systems, typical of timber growing over high water tables, produce a stand which is more susceptible to wind throw. The net result is sudden exposure of mineral soil, often either directly along the stream bank or on side-slopes where efficient transport to the channel is likely. This is an impact which was observed and is well-recognized in the profession.

Attempts to get professional agreement on the best approach to managing SMZs have produced no widely accepted solutions. A thorough examination of alternative practices and treatments to minimize the effects our harvesting activities is needed.

## **5. Road Drainage and Maintenance**

Together, these two categories represented over 40% of the minor impacts and over 30% of the major impacts observed in the Flathead audit. The most common problem was a lack of sufficient cross drains to prevent the buildup of water on the road surface and in the ditches. Another common

problem was a lack of drain features to route water through an SMZ before delivering it to a channel.

Other departures commonly observed included the need for improved drainage features on abandoned or closed roads. There was disagreement on the audit teams in the appropriate application of drain features on these roads. On some sites, closed roads had considerable erosion and were lacking any features to get the excess water off of their surfaces. Some individuals felt this was in accord with the language of the practices which states, "Leave abandoned roads in a condition that provides adequate drainage without further maintenance...."

It was clear that different standards for road drainage were being considered for these roads by some team members. Some felt that erosion of the surface was only important in the context of future travel and since they no longer had to remain passable for vehicle travel, erosion of the surface was not a problem. Since further maintenance would not be conducted, their drainage was adequate, regardless of whether sediment was continuing to move downslope.

For future audits, in advance of the field work, agreement should be reached on what constitutes an abandoned road and what are the appropriate drainage features for these roads.

On a number of sales, infrequent inspection and maintenance of ditches and culverts led to impacts to water

quality. Blocked ditches often forced water onto the road surface causing erosion. Blocked culverts forced water over road surfaces or backed up water in ditches, potentially contributing to saturation of a cut slope, its subsequent failure, and further blocking the pipe. It was found that appropriate design and construction can be negated by inattention to the maintenance and function of those features. Routine inspections are necessary to avoid problems related to these practices.

These road related practices carry considerably more weight in terms of their potential impact to streams and sediment delivery than many of the other practices audited. These practices typically have a direct relationship to impacts, particularly in the locations of stream crossings and the stretch of road leading up to and away from the crossing.

#### **SUMMARY**

Although it is true that forest management in the Flathead Basin appears to be performing at a higher level of practice application and effectiveness than in the rest of Montana, there may still be considerable room for improvement.

It is unrealistic to expect to completely avoid impacts on water quality from timber harvesting-related activities. But, it was demonstrated that in many cases where departures in practices had occurred and impacts were observed as a

result, very little additional work would have been required to correct the situation. An extra water bar on a skid trail, a drain dip on a road, an extra 10 yards of vegetative buffer along a channel, or a cleaned out ditch or culvert were the simple treatments that would have been necessary to eliminate the impact. On sales where SMZs were damaged it would have required very little additional effort for someone to walk the boundary of the designated zone and tie off fluorescent ribbon as a means of delineating areas for protection. Where this was done, there was a noticeable improvement in protection.

It was generally recognized that when BMPs were "adequately applied", meaning applied in such a way that they were effective in "minimizing" sediment production, an "adequate level of protection" was also noted under the effectiveness rating. However, there were cases in which practices were rated as "adequately" applied, and impacts were still observed. The reason for this can be found in the definition of BMPs, which states, "a practice ... determined to be the most effective, practical (including technological, economic and institutional considerations) means of preventing or reducing ... pollution generated by non-point sources..." (40 CFR, 130.2(q)). The key words here are "practical....considerations."

A good example to illustrate how this influences the determination of an "adequate practice application" is found

under the practices associated with "Road Planning and Location". If pre-existing roads, located along stream channels, were used during a timber sale they would be evaluated for "practice application" by balancing the cost of relocating and constructing a new road in a lower risk location against the potential for further impacts from continued use of the road. If teams judged the costs of the new road and the alternative yarding practices to be prohibitive and the amount of sediment produced to be relatively small, then the location of the road would be deemed "adequate." In cases such as this, a practice could be rated as "meeting the intent of BMPs (rating 4)" but score "less than adequate in protecting water quality" on the effectiveness scale. Other practices such as "stable cut slopes in the road prism", and "adequate drainage features on closed or abandoned roads" present similar problems.

This approach represents the trade-offs which are presently being made, as each management activity is weighed against the impacts that it produces and available alternatives - including their costs and practicality. If no practical alternative, short of eliminating a sale, is recognized then practices may be deemed "adequately applied" even though impacts have or are occurring.

This is a good argument against the adequacy of BMPs as a tool to monitor the level of protection provided a

watershed, and for this reason, it is still premature to draw the conclusion that simply because BMPs have been used, there are no impacts occurring in the watershed.

Other concerns, along similar lines, include the interpretation of "What is an adequate level of practice application and protection on sensitive geologic and topographic site conditions?" This begins to deal with the question of "erosional risk" and how management alternatives and specific practices must be altered to reduce the potential for sediment production. What is adequate on some residual soils from belt rock formations has been demonstrated to be totally inadequate on granitics or alluvium. Additional guides and/or language modification may be needed in the BMPs to emphasize this, so that generic application across all land types is not viewed as adequate.

Although the information exists to summarize timber sales by erodible landtypes, it was found that characterizations of an entire sale as "high" to "low" hazard was difficult and conditions were highly variable on-site. Impacts were observed in what were characterized as "low", "moderate" and "high" hazard sites, without any distinct pattern of occurrence. More importantly, these impacts were not so much a reflection of how the entire sale area was characterized, but instead on how the "higher" hazard micro-sites within the sale boundary were evaluated for appropriate practice selection and treated. This

is where a more thorough on-site pre-sale review, revised BMPs or field guides for correct application are necessary to avoid problems.

It was difficult to assess what the real impacts to water quality were from the silvicultural treatments observed on these 52 timber sales, and that was purely beyond the scope of this project. It was noted, however, that strictly from a water quality standpoint, the surface erosion in the clearcut treatments was no greater than that in other treatments. Even on those sites with slope steepness of greater than 60% it appeared that very little sediment was moving downslope. The greatest observable water quality risk that clearcutting produced was in the opening of the canopy and the associated "blowdown" of stands adjacent to stream channels. This introduced a considerable amount of sediment into the channels from the root masses and upset the stability of the banks, undoubtedly with long-term damage and impacts to water quality.

It seemed that road location, excessive disturbance with equipment in and around stream channels and wet areas, and the handling of water from skid trails and abandoned roads were far more important than the slope steepness or silvicultural treatment.

The problems observed can not be attributed to a single ownership, although the non-industrial private ownership

showed consistently higher departures and impacts. Nor can problems be saddled entirely upon the administrators and equipment operators, as timber sale planning has been shown to contribute as well.

Practices in the Flathead Basin do not have to be drastically changed or improved upon in order to significantly improve the level of protection. As we found, many of the practices are already being applied. What is needed is an improvement in the "consistency" with which these practices are applied. This can be achieved by not only educating the professionals on the ground, but by getting management to rally behind these practices, take an active interest in applying them, and support their people in applying, what are for the most part, cost-effective land management practices.

At a time when the timber industry in Montana is facing increasing pressure from the public, additional attention to these practices could go along way toward improving the working relationship between those groups striving for balanced use of our forested lands.

This study is the most intensive on-site examination of best management practices for forestry ever conducted in Montana. Future assessments of this type will serve to not only measure the level of protection being implemented to control sediment production, but will also evaluate the performance in those areas where this report indicates

improvements are necessary. In addition, these assessments will provide feedback on the success of educational programs, provide the continued input for refinements in the BMPs language and their appropriate application under varying site conditions, and provide resource managers the opportunity to interact and explore those forest watershed relationships which are influenced by their practices.

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